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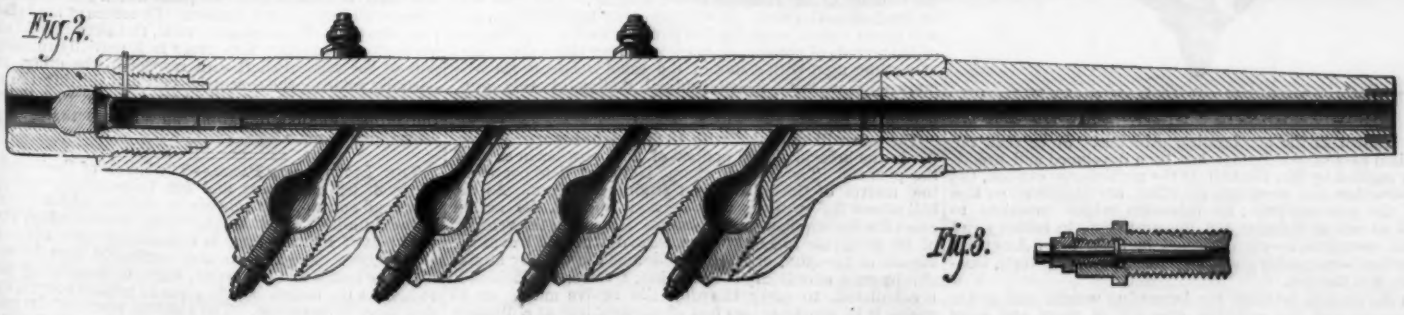
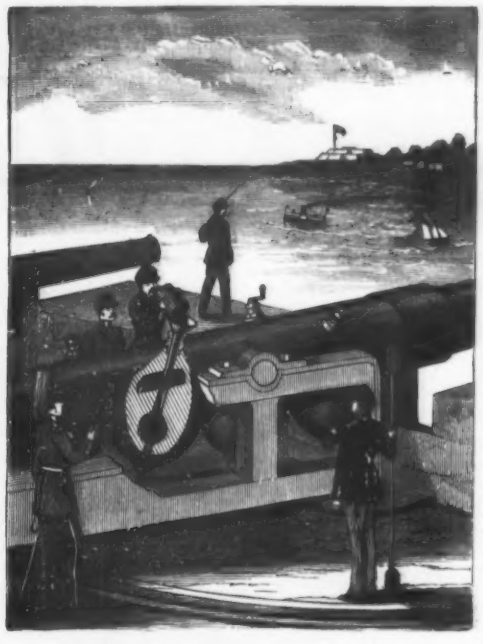


THE LYMAN-HASKELL MULTIPLE CHARGE ACCELERATING GUN.

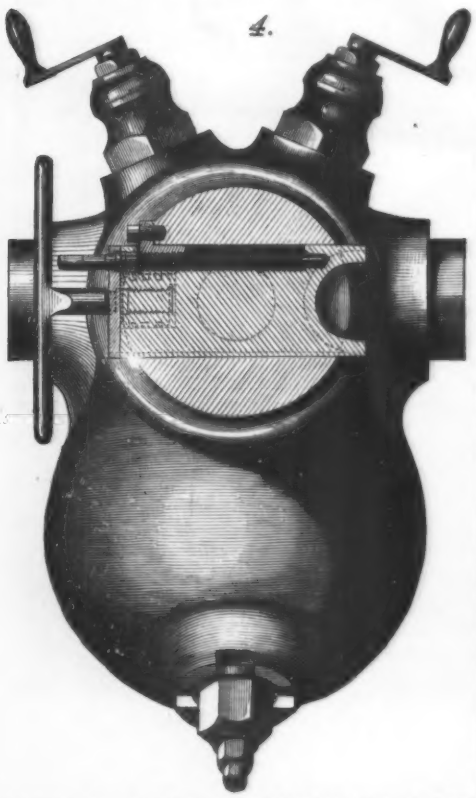
THE LYMAN-HASKELL GUN.

IT would seem to be the rule in military as well as in other arts, that radical improvements are more apt to be made by non-professionals than by those whose lives are devoted to the particular art or service improved. The latter perfect the means and methods which they are educated to use; they do not revolutionize them. It is the outside inventor who sees where radically novel changes can be advantageously made. Freedom from professional bias is often, indeed, a prerequisite for successful effort in invention. And it may be that the professional prejudice which the inventor of striking boldness and originality is sure to encounter is one of the conditions of a thoroughly practical development of his ideas.



LOADING THE LYMAN-HASKELL GUN.

When the stress of war was upon the country, twenty years ago, the attention of our inventive minds was largely directed to the production and development of military and naval devices, some of which, like the revolving turret, the breech-loading rifle, and the magazine gun, had been dormant, so to speak, for years. Other ideas, equally revolutionary in character, were suggested by the needs of the time, but the war was happily ended before they could be developed. Among these was the idea of increasing the efficiency of firearms, particularly heavy guns, by what is



SECTION OF BREECH OF LYMAN-HASKELL GUN.

now known as the accelerating principle. Since then the orininal idea of Mr. Lyman has been developed and practically applied by Mr. Haskell, in the multicharge cannon, the construction and mounting of which are illustrated on this and the previous page; an invention which promises to work as radical changes and improvements in military and naval operations as were effected by those other American inventions—magazine guns, torpedoes, revolving forts, ironclads, and the rest.

In the contest between the increasing weight and power of cannon and the resisting strength of more and more heavily armored defenses, two radically different lines of effort have been followed. Within the profession, capacity in guns to hurl heavy projectiles at great velocity has been sought for by increasing the size and strength of the gun; by chambering the breech to make room for a large volume of powder to be exploded; and by moulding the powder to secure accelerating combustion, slow at first to start the projectile, then more and more rapid to burn all the powder and attain the maximum pressure while the projectile was passing through the gun. By these improvements it has been found possible to increase the charge of powder to one-fifth the weight of the projectile, enabling a properly constructed gun to deliver a shot with such force and velocity as to cause it to penetrate somewhat more than as many inches of iron as the diameter of the bore of the gun measures. Under the most favorable conditions the heaviest Armstrong gun (100 tons) has penetrated nearly one and a half calibers, or about two feet of wrought iron, with a caliber of seventeen inches. Increase of efficiency is secured on the accelerating principle by devices for firing successive charges of powder behind the ball while the ball is passing through the gun. In this way the projectile is thrown by the explosive force of more than its weight of powder, or five to ten times as much as can be burnt behind a ball by the conventional method.

The inventors claim that, notwithstanding the greatly increased charge of powder under the new principle, the maximum pressure within the gun is not increased. By the old method almost all the strain is upon the metal about the breech of the gun, while by the new the strain is distributed along the entire length of the gun. As a natural consequence of the increased charge a longer and heavier projectile can be employed, and the increased velocity with which it leaves the gun enables it to penetrate iron armor to a depth from four to ten times the caliber of the gun, according to the number of accelerating charges.

Two official tests of the efficiency of multicharge guns have been made before boards of officers of the army and navy, some of the experiments being made for range, others for penetration, and still others for initial velocity. On every point the reports show a decided superiority in favor of the multicharge guns, compared with other guns of equal or greater weight. So marked is the superiority of the accelerating principle that General John W. Newton, U. S. A., calculates that a 10-inch accelerating gun would be as efficient as the 81-ton (16-inch) Armstrong gun, and nearly as efficient as the 100-ton (17-inch) Armstrong, while the latter would be surpassed in efficiency by a 12-inch Lyman-Haskell gun. In the matter of cost and the expedition with which guns of a required penetration could be furnished the advantage seems to be as markedly on the side of the multicharge guns.

A still further advantage is promised by the new system in the relatively smaller cost of mounting, whether on land or water. The cost of a Duilio, carrying a 100-ton gun—the most powerful vessel afloat—would suffice for the building and arming of several small swift steamers armed with cheaper and lighter but equally efficient accelerating guns, while the larger craft would present a much better mark to hit than her smaller adversaries. In like manner a few properly mounted accelerating guns of ten or twelve miles range, commanding any of our harbors, would make them practically inaccessible to the most powerful war ships that could be floated.

In the SCIENTIFIC AMERICAN of November 12, 1881, was described the casting of a 6-inch Lyman and Haskell gun at the foundry of the Reading Iron Company. The gun will be finished next spring. It will be twenty-five feet long, and will throw a shot weighing 150 pounds, with a total charge of 130 pounds of powder, or more than four times the weight of powder used with a shot of the same weight in the best guns now in use. A longitudinal section of this gun, showing the supplementary powder pockets, appears in Fig. 2.

The gun will be loaded with 18 pounds of hexagonal powder in the breech, and 28 pounds of finer powder in each of the pockets. The breech charge is intended to overcome the inertia of the ball without straining the gun. As the ball passes the openings to the several pockets, the heated gases fire the supplementary charges, increasing the velocity of the projectile to 4,000 feet a second when it leaves the muzzle of the gun, or more than double the velocity attainable by guns of ordinary construction, a velocity sufficient, it is calculated, to carry the projectile twelve miles, or to enable it to penetrate two feet of wrought iron at a distance of 200 yards. The explosion takes place in tough steel backed by strong cast iron. The manner of charging the breech chamber and the several pockets is shown in the smaller cuts.

Touching the practicability of the methods of loading and firing guns on this principle, as developed by Messrs. Lyman & Haskell, we have the testimony of General Newton to the effect that no doubts are entertained by experts that the gas check can be made perfectly efficient, while, in his opinion, the loading of the pockets can be made as expeditious as the loading of the breech.

The contractors for the construction of the gun we have illustrated are Messrs. Pancoast & Tarr, agents in this city for the Reading Iron Company.

The SCIENTIFIC AMERICAN of August 4 has the following:

COMPLETION OF THE GREAT LYMAN-HASKELL GUN.

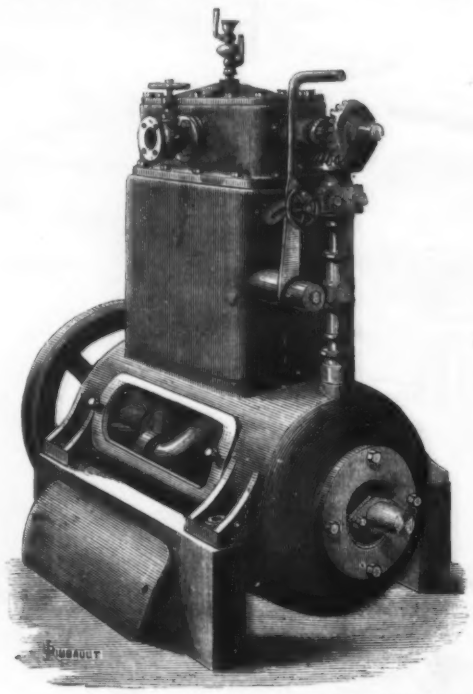
The twenty-five ton gun, twenty-five feet long, which has been in process of manufacture during the year past by the Reading, Pa., Iron Company, is at last completed, and is a splendid piece of workmanship. This remarkable weapon has the following peculiarities of construction:

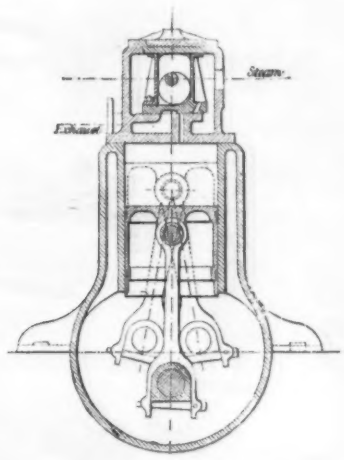
Hanging from the under after part of the gun are four large protuberances arranged in a line, each something like a cow's bag. These protuberances contain pockets for holding powder, and they communicate with the bore of the gun. The latter is charged at the breech with eighteen pounds of powder, against which the projectile rests in the ordinary manner; each of the pockets is intended to contain twenty-eight pounds of powder.

The firing of the breech charge starts the projectile, which is successively accelerated, on passing the several pockets, by the firing of the powder charges contained in them, which are set off by the flame within the cannon. In this way five successive charges are made to act against the projectile, which leaves the gun with a tremendous velocity. It is expected that this cannon will revolutionize the art of gunnery; it is believed that it will carry its ball twelve or fifteen miles, and go through iron plates two feet in thickness. The new gun is now on its way to Sandy Hook, N.Y., where it is soon to be tested before a board of army and navy officers, under a special Congressional appropriation

IMPROVED HIGH-SPEED ENGINE.

WE annex engravings, from *Engineering*, of Ridealgh's high-speed engine, constructed by Messrs. Welford Brothers, King's House Works, Sunderland, exhibited by them at the late Engineering and Metal Trades Exhibition, London. The pattern of engine shown by the perspective view is intended for use in steam launches, and is fitted with reversing gear, while that shown by the section is for driving dynamo machines or other similar purposes when a very high speed is required.





IMPROVED HIGH-SPEED ENGINE.

Each engine has three single acting cylinders, the steam being admitted to and released from each cylinder by an ordinary slide valve working horizontally on a face in the top cylinder cover, as shown in the section. The valves are driven direct by eccentrics formed on an eccentric shaft, which passes along the tops of the cylinders above the valve faces, and which is driven from the crankshaft by bevel gear, as shown in the perspective view. When the engine is made for reversing, the vertical intermediate shaft (through which the motion is transmitted from the crankshaft to the eccentric shaft) is divided into two parts which are connected by a sleeve sliding a spiral feather. By means of the bell-crank lever shown in the perspective view, this sleeve can be shifted vertically, the motion thus given to it partially rotating one part of the vertical shaft with respect to the other, and so partially rotating the eccentric shaft and shifting the eccentrics from the position in which they would give the valves the proper motion for going ahead, into that for going astern, or *vice versa*.

THE LIGHTING OF PARIS.—The streets of Paris are lighted by 43,089 gas lamps, and 429 lamps which burn petroleum and colza oil. There are in addition 25,000 jets of gas in the buildings which belong to the municipality, and the total cost of lighting them is estimated for the current year at £260,000. The gas company employ 76 men in looking after the lamps and the mains, many of them being told off to inspect the meters and the pipes in private houses, and see that there is no escape. The lighting power of the gas supplied by the company is tested in eleven laboratories situated in different parts of the city.

IMPROVED LOCOMOTIVE AND TENDER.

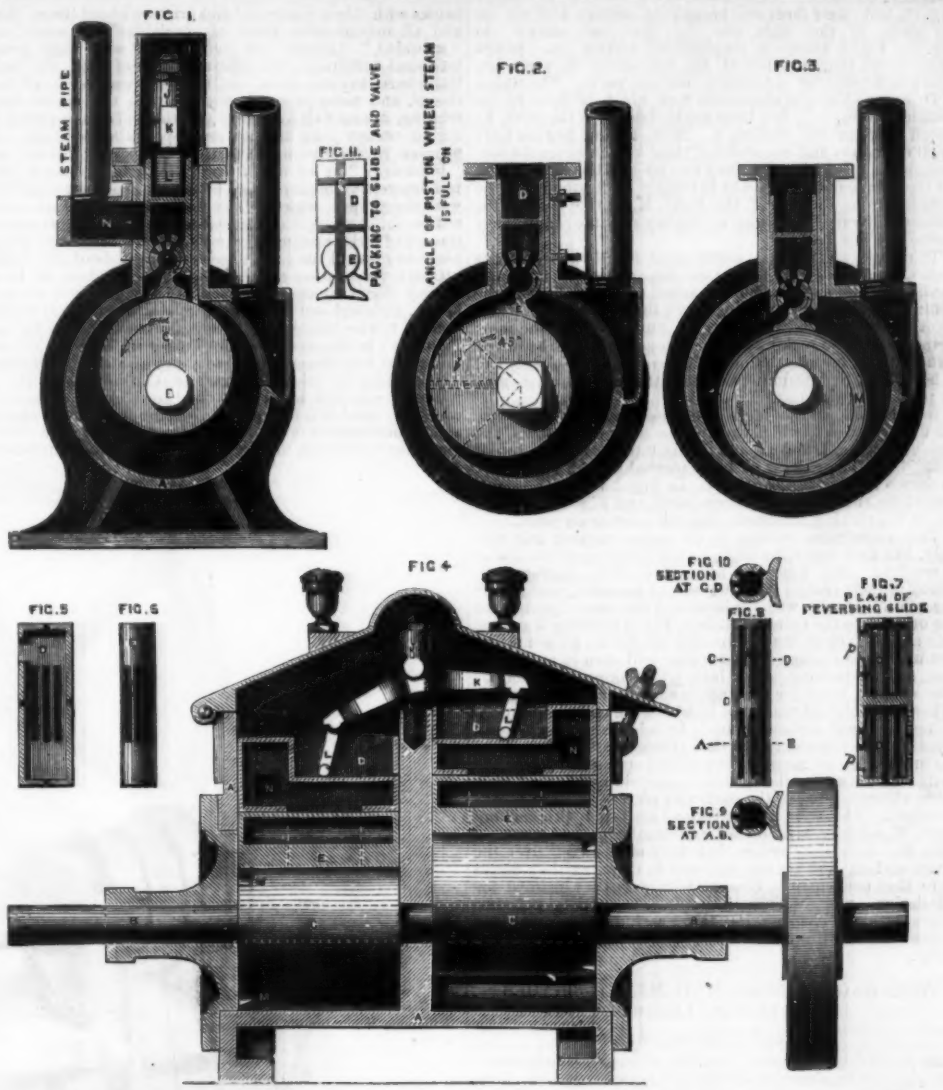
Diameter of Cylinders	21 in.
Stroke of Cylinders	36 "
Diameter of Driving Wheels	4 ft. 9 "
Driving Wheel Base	19 " 7 "
Rigid Wheel Base	14 " 7 "
Total Length of Engine and Tender	65 " 5 "
Total Weight of Engine	73 tons.
Weight on Driving Wheels	64 "
Weight of Tender (light)	50,650 lbs.
Capacity of Tender	3,600 gal.

The peculiarities of the valve gear of this engine are shown in the engravings. A sword-arm rotating on the center of its length and located near the steam chest is driven by a rock-arm connection from an eccentric, or a return crank from the main pin, thus allowing the fire box to be extended if necessary to the extent of the room occupied by the eccentrics. A block, sweeping from end to end of the sword arm, drives a vibrating bar connected with the T-headed lever, which swings from this bar, as shown. To each end of the short arms of this lever a valve stem is connected, which drives the slide valves located at each end of the cylinder. These valves have the Allen principle of supplementary steam passage in the valve extended to the exhaust as well as the admission. The lower end of the T-headed lever receives its motion from the crosshead. The action is somewhat similar to the Corliss wrist plate, and gives an exceedingly rapid opening and closing of the valve. On a 17x30-inch cylinder fitted with this gear, the steam port is opened wide as soon as the crosshead travels two inches, the valve remaining nearly stationary until 28 inches of the stroke is completed, when it closes as suddenly as it opened. This peculiar action is due to the partial rotation of the lever around its pivoted point in combination with a positive movement from the sword arm. When the engine is cut up to 9 inches, the admission provided by the valve is ⅞ of an inch as against ⅜ of an inch if the gear were an ordinary shifting link. The exhaust is not opened until 27 inches of the stroke is completed, when cutting off at practically one-fourth of the stroke. The compression commences as late as is desired, and rises to the chest pressure.

But one engine has yet been built with this gear, but it is the intention to apply it to all engines on the road that require new cylinders, and as fast as possible. The illustrations are from the working drawings of a larger engine than the one built, but they show perfectly the application of the gear. The engine already built, and also the larger ones to be built, are intended for heavy hill work.—*Nat. Car-Builder.*

IMPROVED ROTARY ENGINE.

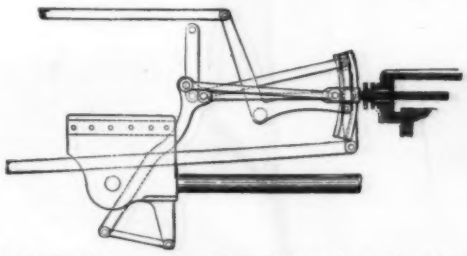
THE problem of constructing a really satisfactory rotary engine remains a difficult one, and though many attempts are made every year, few accomplish any real advance. Our attention has recently been called to a rotary engine patented by Mr. J. Pinchbeck, of Victoria chambers, which has some novelties that may be described by reference to the accompanying drawings. We are informed that one engine of this kind has been constructed by Messrs. Waygood and Co., of Newington Works, Great Dover street, S. E., with cylinders 8 in. diameter, and that at a velocity of 500 revolutions per minute the power taken on the dynamometer was 8 horses. It will be noticed that the angles made by any radius or any tangent of the pistons in their revolutions give a lateral motion to the rocking abutments, which is utilized for the purpose of admitting and cutting off steam in the cylinder, thus dispensing with the employment of a separate valve and eccentric for that purpose. The abutments are held down on to the pistons by a mechanical connection between them, the ascent of one piston causing the descent of the abutment on to the descending piston, only sufficient pressure being applied to keep the surfaces in contact.



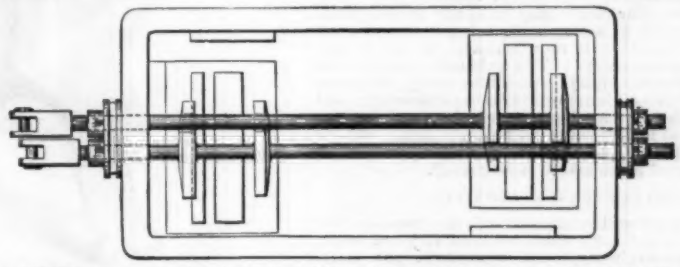
IMPROVED EXPANSION AND REVERSING ROTARY ENGINE.

In the engravings, Figs. 1, 2, 3 are sections of the cylinder, showing the piston in different positions. In Fig. 1 the ports are beginning to open, and the abutment valve, E, is turning toward the exhaust port in the direction shown by the small arrow. Fig. 2 shows the piston at 90 deg., the steam ports being fully open. Fig. 3, the piston is at 180 deg., and the ports are closed, the abutment turning away from exhaust, as shown again by the small arrow. From this point the steam expands till the piston reaches the exhaust port, when it is discharged into the atmosphere. The travel of the abutment is rapid both at the top and bottom, but it is almost *nil* from 45 deg. to 135 deg., when, at that angle, the shutting of the ports is as rapid as was the admission.

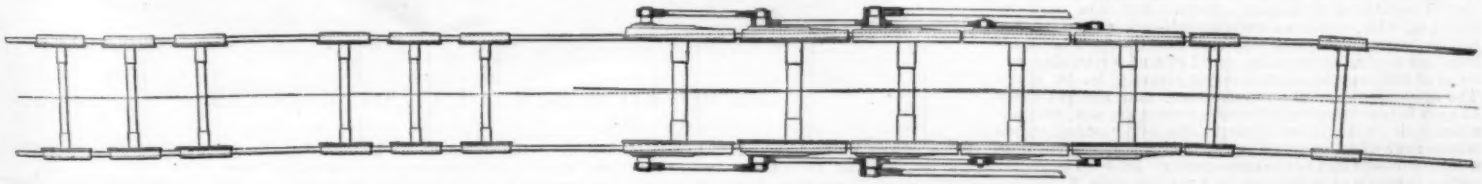
The radial slides, D D, are hollow, and are always open to the steam through the openings, N N. They are fitted with metallic packing held forward by spiral springs, as shown in



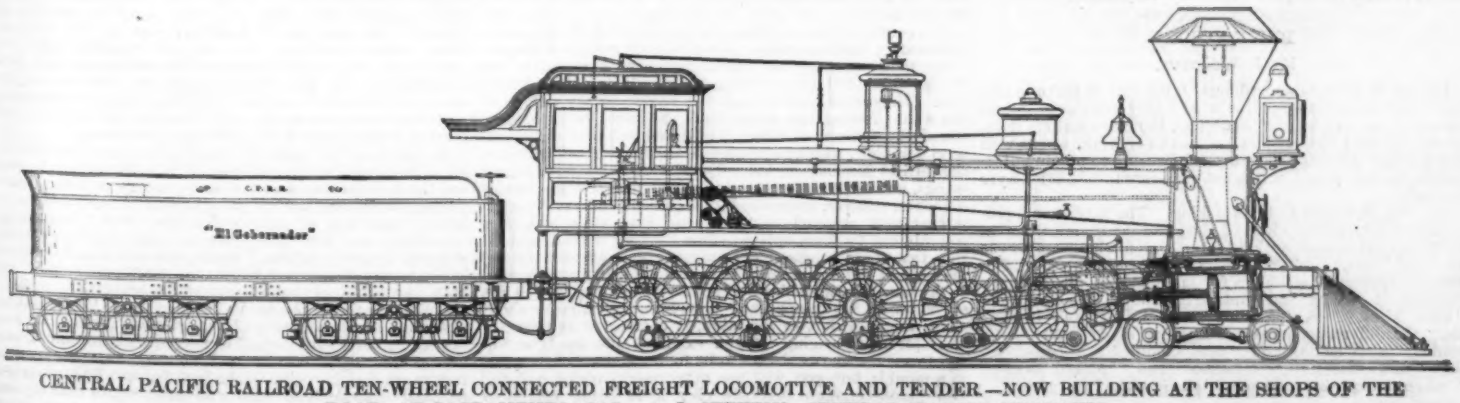
VALVE-GEAR, WITH PISTON AT END OF STROKE, DESIGNED BY A. J. STEVENS.



PLAN OF STEAM CHEST, SHOWING VALVE SEATS AND STEMS.



PLAN SHOWING ENGINE WHEELS ON 12° CURVE.—RAILS SPIKED TO GAUGE 4 FT. 8½ IN.



CENTRAL PACIFIC RAILROAD TEN-WHEEL CONNECTED FREIGHT LOCOMOTIVE AND TENDER.—NOW BUILDING AT THE SHOPS OF THE ROAD, AT SACRAMENTO, CAL.—A. J. STEVENS, GENERAL MASTER MECHANIC.

Fig. 11, and their faces are brought in contact with the inner faces of the slide case by set-screws, shown in Fig. 3. Fig. 4 shows a longitudinal section, one piston being at the top, the other at the bottom of the cylinder, which is divided by a partition into two parts. The slides, D D, upon which the abutments rock, are held down by the distance pieces, L L, and these are held down by the lever, K, which rocks on the centers, J. Now, as the pistons have equal diameters and eccentricity, their velocities are similar, though the pistons are traveling one up and the other down. As the abutments rock it will be readily understood that the distance from the top of the lever, K, to the face of the pistons will vary according to the sines of the angles they make—see Fig. 2.

To compensate for this variation of length, the distance pieces, L, are caused to assume the same angle, and thus compensate for the various lengths caused by the rocking of the abutments, so that by screwing down the nuts on J, just sufficient pressure may be, it is expected, put on to keep the faces of the pistons and rocking abutment together, and to be steam-tight without undue friction. The cover, I, fits closely and is held down by a thumbscrew, that the working parts may be protected from dust.

In order to keep the faces lubricated, two oil cups are fixed on the cover, which drop on the lever ends down the distance pieces, L and L, and finally into the well on top of the slides. These have oil holes pierced in their four sides, as shown in Figs. 2, 3, 4, and 5. In Fig. 5 we have a section of the slides, D, with steam ports, and Fig. 6 shows the top of the rocking abutment, also with the steam ports.

This description relates to an engine running one way only, but for a reversing engine a modification of the slides is required. Fig. 7 shows a plan of the slides having a division in their center, with two sets of passages, and Fig. 8 the abutment, also with division and two sets of ports; but the outlet into the cylinder differs, Fig. 9 showing it on one side and Fig. 10 on the reverse side of piston. By admitting steam into the passage, *p*, the engine will turn in one direction, and by turning steam into, p^1, the opposite direction. The exhaust pipes for such an arrangement are duplicated. Where the pistons touch the inside of the cylinder they do so on a curved surface about ⅛ in. wide, and which corresponds to the inner curve of the cylinder; as these wear they are brought up by means of set screws acting on the square shaft which carries the pistons, a certain amount of play being allowed between the shaft and pistons to allow of adjustment. The ends of the pistons are fitted with packing rings, M, slightly bevel on their external edge, and eccentric with the covers, in order that they may sweep over the entire surface and not cut channels in them, as they would were they concentric. Several advantages are claimed for this design, among which are simple construction, noiseless action at high velocities, the few wearing parts—and these become tighter from wear—and small friction.—*The Engineer.*

THE ENGINEERING AND METAL TRADES EXHIBITION, LONDON.

PARKER'S SCREW MACHINE.

As might be anticipated, machine tools are largely represented at the Engineering and Metal Trades Exhibition, London. We illustrate two machines constructed by Messrs. Greenwood & Batley, of Leeds. One of these is Parker's automatic screw-making machine. The great feature of this ingenious piece of mechanism is the continuity of its action, and the small demand it makes upon the attention of the attendant. After a rod of steel, iron, or brass has been inserted into the hollow mandrel, screws of the form to which the tools have been previously adjusted, are turned, chased, and cut off, one after another entirely automatically, the various tools coming into action in due succession, and the wire being fed forward at proper intervals. The work turned out is uniform in length, diameter, and form of thread, and is suitable for all kinds of machinery, even of the highest class. The heads may be of any desired form, cheese, countersunk, or button heads being produced with equal facility, while three or four diameters of shanks may be turned on the same screw. The tools and screwing die are of the simplest description, and can be easily sharpened and adjusted, while oil is applied to them continuously and is used again and again. Thus it will be seen that the duties of the man in charge are exceedingly light, and he can easily attend to two or three machines, and consequently the cost of manufacture is very small.

BAND SAW FOR IRON AND STEEL.

The other engraving illustrates a band saw machine for cutting cold iron and steel, which has been very successful and is now extensively employed in arsenals, gun factories, locomotive shops, and the like, for cutting out gun-carriages, boilers, tender and wagon framings, ships' plates, etc. The table of the machine shown is 2 ft. 8 in. long by 2 ft. 4 in. wide, and has a variable self-acting feed motion of 2 ft., with a self-acting stop motion. Charge wheels are provided to give the requisite speed of feed for cutting material of different thicknesses varying from ⅜ in. to 10 in. The saw pulleys are 40 in. in diameter, and the periphery of each is covered with leather to prevent the saw, which is about ⅞ in. wide, from slipping. The lower pulley is cast with a spur wheel on its outer rim, and this is driven from a pinion on one end of the cone pulley shaft. The upper pulley is mounted in bearings in a vertical slide, which has a screw adjustment to accommodate various lengths of saws and to provide the requisite tension.—*Engineering.*

BRICKWORK.*

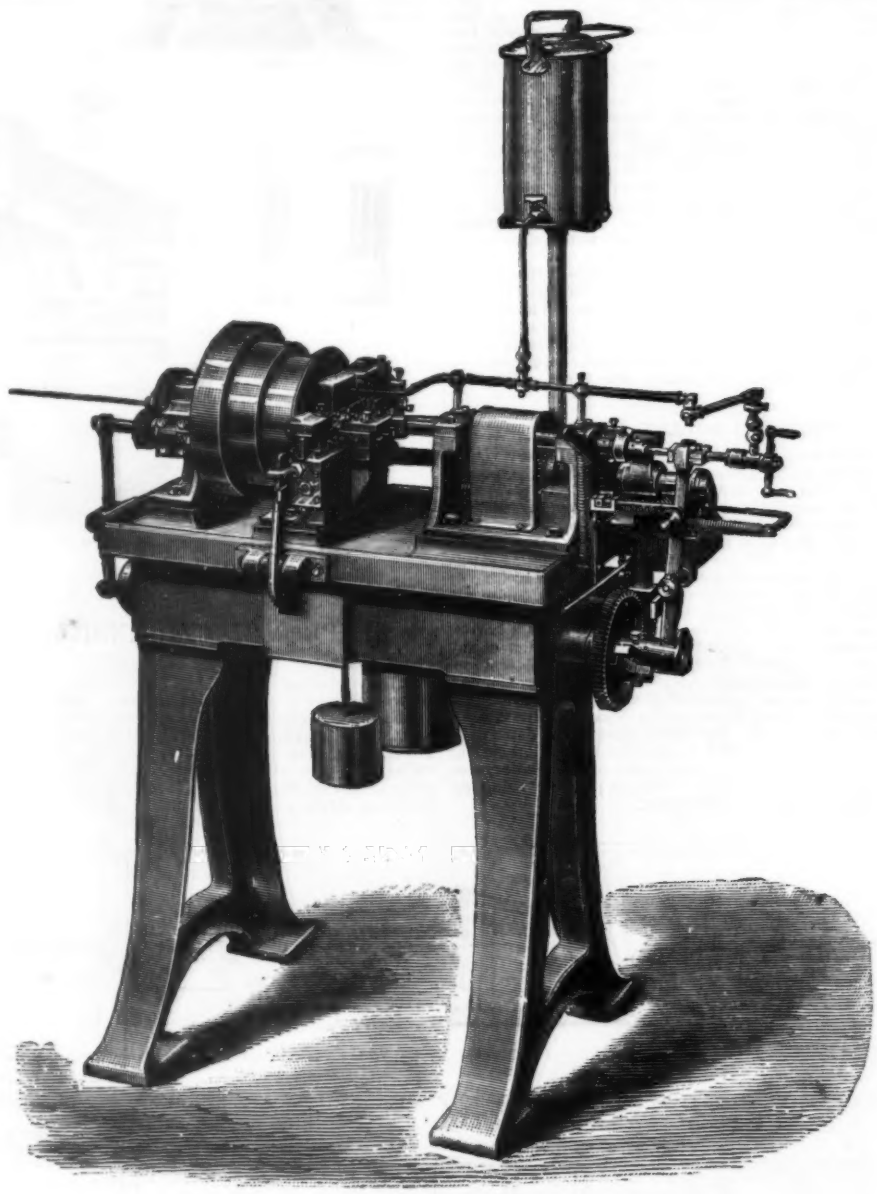
By J. Woodley.

It may be thought superfluous on my part to make in this paper any attempt to describe what I may call the historical phases of my subject, for, doubtless, those are matters upon which the majority, at least, of clerks of works are as well if not better informed than myself, because to obtain information in that direction it is not necessary to be a bricklayer by trade.

So, also, in regard to brickmaking. The nature and properties of the various kinds of clay, and the chemical action of the several component parts, the reason why some bricks are "red," some "white," others "yellow," etc.; the different descriptions of machines for making, and the ordinary methods of drying and burning, such as "clamps" and "close-kilns," "Scotch kilns" and "Haufman's ovens," etc.; the difference between "machine made" and "hand made," "slop made" and "sand moulded," "pressed facings" and wire cuts," "malms" and "picked stocks," "rough stocks" and "grissels," "place bricks" and "shuffs," bricks with "frog sinkings" and bricks without them; these, and all innumerable kinds of specialties in "plain" and "moulded," "glazed" or "enameled," with their several technical definitions, the relative merits of each, the localities where they are made, and means of transport; all these things, and many others connected with the art of brickmaking, are so well known to you that it is unnecessary for me to occupy your time by any description of them. My purpose is, for the most part, to deal with "bricks" and "brickwork" as we find them. Nevertheless, there are a few interesting matters of an historical character connected with the subject, which, albeit they are so well known, may not be out of place if mentioned here. One thing is certain, the art of brickmaking is of very ancient origin, as it has a place in some of the earliest recorded periods of the world's history; for we may all read that the children of Israel, during their sojourn in Egypt, were compelled to make bricks, although we are left entirely in the dark as to what kind of bricks they were. We again read of "bricks" and "mortar" in the story of the Tower of Babel. We also know that our former conquerors and masters, the Romans, were famous for brickmaking; and it is more than likely it was they who first introduced this most useful art into this country. And it is interesting to mark the various changes and improvements in the form of the bricks and the character of the brickwork that have taken place since our first initiation, a sure guide to which is to be found in the numerous remains that have from time to time been brought to light. As an illustration, I will just describe to you an instance which recently came under my own immediate notice. A little more than two years ago I was engaged upon the restoration of one of the most dilapidated old churches in the county of Essex, situate in the parish of Weeley, near Colchester; and, in pulling down the old rubble walls, we came upon some very interesting specimens of ancient bricks in a good state of preservation, one of which I place before you. They were built in with the rubble in the section of the wall. And at the same time, and near the spot, were found the remains of a base, shaft, and cap of a stone column complete, which the architect described as belonging to the earliest Norman period. There were two kinds of these bricks, and both had evidently formed part of some former edifice or edifices, from the fact that some of the original mortar still adhered to them, and that some had been roughly cut to form splays. Now, taking into consideration that these bricks were found in company with the old masonry, I think you will agree with me that they belonged to the same period, at least (if not an earlier one), which was stated to be 800 years ago. There is a peculiarity about these bricks which, to my mind, is conclusive evidence of their primitive origin. If you examine this one, you will fail to see the marks always to be found about bricks made in a mould; but you will see other marks which will tell you plainly enough that the clay, after being beaten or rolled out to the required thickness, was cut into slices with a wooden cutter, a pallet laid on the top giving the size and shape, and when put out to dry, the slices were laid flat upon a straw bed, the impressions of the straw being still upon them. There is one other matter in relation to these old bricks I should like to mention here, because it may, perhaps, strike you more forcibly further on. In digging the new foundation, we came across some clay of a peculiarly fine description. Curiosity tempting me, I compared these bricks with it, and at once came to the conclusion that those bricks were made from that kind of clay, and therefore made on that very spot. The old tower, evidently an after-erection to the church—and left still standing—is built entirely of brick of two distinct periods, clearly defined. The lower and older portion is of a very rude description, the bricks are 11½ inches long, 5¼ inches wide, and although only 2¾ inches thick, four courses of the brickwork will measure 13½ inches in height, made up with large joints of coarse mortar, which, notwithstanding its great age, is still sound. The upper and newer portion, judging by the size and shape of the bricks, and the character of the work, I should say belonged to the last century. The fact that the new church is also built of brick adds to the interest I attach to this one building in particular, showing, as it does, in itself and in connection with the old bricks which I have described to you—nearly all of which I purposely had built in the new walls—four living examples of as many periods in the history of brickwork, separated from each other, I may say, by hundreds of years.

I mentioned just now the subject of bricks being made on the site of the building. Now, if we carefully consider this matter in connection with the fact—at least, generally understood as such—that there is hardly a district in England wherein clay may not be found of more or less value for brick making purposes, then we shall have discovered the reason, not only why bricks were first made, and brickwork first adopted, but also why it has gone on from time to time and period to period increasing in importance, and becoming more and more a necessity, until it has become in the present day the leading feature in building construction.

To continue this part of the subject yet a little further, let us just consider the part played by brickwork in London and the metropolitan districts during the last, say, fifty years; during which time it is no exaggeration to say, the greater half of what may be justly called the "New" London has been built, and the "Old" London almost entirely reconstructed in even less time. Again, consider what it has done in the matter of railways within the metropolitan area; not only above ground in the innumerable bridges and miles of viaducts where we can see it, but also in the long stretches of tunnels and retaining walls underground, where we cannot see it, but where it must of necessity exist in more massive proportions. Now, may I not say these stupendous results are mainly owing to the fact that this huge metropolis partly stands upon what was—and is now entirely surrounded, at easy distances, by what is—"one vast brick-



IMPROVED SCREW CUTTING MACHINE.

*Read before the Clerks of Works' Association.—*Building News.*

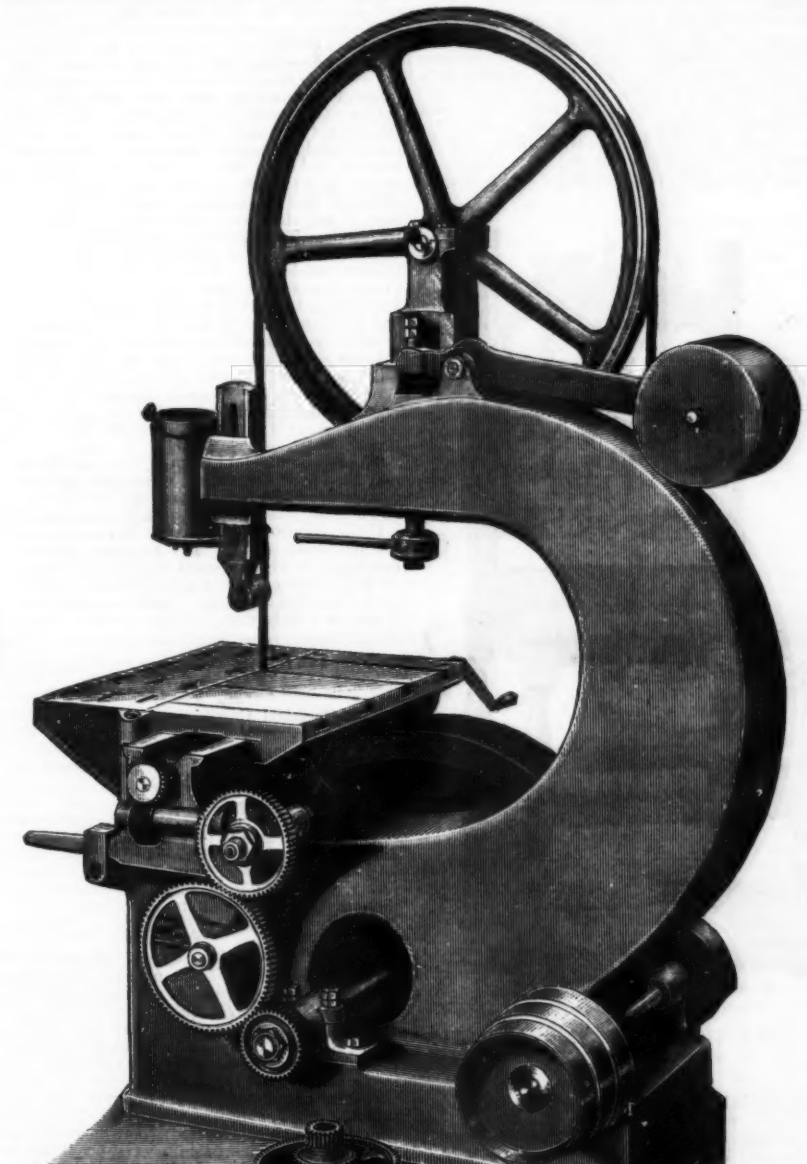
field"? Then, again, let us turn to the provinces, where we may find scores of instances of similar causes and effects—for example, see the town of Reading, in Berkshire, one mass of red brick. See Aldershot and its Government buildings and barracks, which, previous to the Crimean war, was a large tract of common, little better than waste land, and an obscure village consisting of about a dozen cottages. Another notable example is the Victoria Hospital, Netley, near Southampton. Some faint idea may be formed of its magnitude when I say that the foundations of the main blocks alone absorbed 5,000,000 of bricks to raise them to the plinth line; that as many as 10,000,000 of bricks were made in the one year that I was engaged upon it; and that it occupied many years in its erection and completion, and the whole of the bricks were made on adjoining land.

Colney Hatch Lunatic Asylum, and the fortification works at Newhaven, Sussex, are both striking examples, containing many millions of bricks, made on the land immediately contiguous to where they stand.

The subject is so important as showing the value of brick over every other material for a like purpose, that I cannot refrain from mentioning (even at the risk of wearying you) one or two other especial instances, in the case of country mansions of no mean dimensions and character, erected in recent years, the bricks for which were actually made on the bonded by another, it is—or at least it ought to be—rendered perfectly homogeneous, whereby the maximum of strength is obtained with the minimum of bulk. It also affects cost, by enabling alterations and adaptations to be made with the greatest amount of simplicity and expedition, also openings to be formed, flues and chimneys to be built, projections thrown forward, recesses set back, and all the various constructional changes in form and feature, either in regard to strength, ornamentation, or variety in color, with the least amount of additional labor, and without interfering with the integrity of the mass.

Apart from the foregoing, resistance to fire is not the least of the many reasons why brickwork takes first rank in comparison with any other building material. We know it to be of common occurrence for a brick building to be completely gutted by fire from foundation to roof, and yet the walls remain intact, so that, with a little dressing and cleaning, a few bricks replaced here and there, they are ready to receive a fresh inside and a new roof, apparently none the worse for the ordeal they have gone through.

Now, having said thus much, I feel confident I have said sufficient to convince the most skeptical there is something in and about brickwork worth a little more than a casual or superficial acquaintance; that it is a subject upon which we, at least, as clerks of works—a part of whose duty it is to see



IMPROVED BAND SAW FOR IRON.

estate upon which they stand, viz., Wyfold Court, Oxfordshire (afterward burnt down and just now rebuilt); Blackmore Park Mansion, near Malvern, Worcestershire; Eaton Hall, Cheshire; Stanstead Hall, Essex; and I dare say there is not one of you but could name other instances of similar character and equal importance. These facts may be taken as a fair sample of what has been done and what is doing throughout the country generally, and quite sufficient to justify my remarks in respect to the position held by brickwork in building matters. But there are other very cogent reasons why this position must and always will be maintained, the keynote to which is the uniformity of the parts, every brick being in size and shape the counterpart of each other. This fact affects cost in transport, for the greatest number of bricks can be stowed in the smallest amount of space, and gives the greatest facility for handling, in being transferred from one place, or one conveyance, to another, or from any conveyance on to the building site, and thence to the hands of the bricklayers. Again, it affects cost in construction; for the walls being adapted to the size and shape of the bricks, there is a place for every brick, or a portion of a brick, and a brick for every place, without waste, and with, at most, a mere shadow of pretence for chipping and fitting; and also allows for the greatest rapidity of manipulation; and, by the mathematical exactness and nicety with which each brick takes its place in relation to and can be it executed—may profitably bestow a little careful attention and study. I am constrained to make these remarks because I am tolerably certain that hitherto it has not received the amount of attention which its ever increasing importance demands, either on the part of those who are called upon to supervise its execution—be they foremen or clerks of works—or on the part of those who actually perform the work. It is a well known fact that of all the handicrafts connected with the building trade there are none looked upon with so much apathy, not to say contempt, as bricklaying—resulting from the popular delusion frequently expressed in words similar to these: "Anybody can lay bricks;" "There is nothing in it to learn;" The greatest dunce is fit to make a bricklayer," etc. Now, having spent a long life among it—from an apprentice upward—and during the last thirty-two years made it an especial study, I am enabled to speak with some authority, when I say that no branch in the trade is so little understood as brickwork, either in regard to its numerous technical details, the fundamental principles underlying them, or the extent to which they are capable of being applied; and, although I may be thought to exaggerate, I know it to be a fact that hundreds of bricklayers, even, grope about for a lifetime without acquiring more than just the merest rudiments of the craft; and no wonder, simply because it is so seldom they are told there is anything beyond that to learn. They are, as a rule, left to their shifts, each one to go on in his own fashion, piling the bricks one upon another without the least regard to the integrity or the perfectness of the work, beyond what is seen on the face; and, in too many instances, very little care about that even. So long as the contractor or his foreman (too frequently a sub) can see it "grow," and the clerk of works, as he passes along, sees the top flushed up—but which is, more often than not, merely plastered over—there is an end of it. Or, if perchance there should be one man among the gang who is really skillful and disposed to manipulate his portion of the work correctly and well, his intentions are neutralized by the others, who, having neither ability nor disposition, are careless in the matter; indeed, it would almost appear strange were it otherwise, seeing their remuneration at the pay office is the same.

It is from a knowledge of these facts that I have been led, for years past, standing almost, as I may say, alone, to use my voice and pen—accompanied at times, by actual practical teaching—in an earnest endeavor to bring about a better state of things; but, although I have the satisfaction of knowing that in many instances and in certain quarters, my efforts have been somewhat successful, yet it is but a drop in the ocean compared with what is needed to be done. I feel convinced, therefore, that a fresh starting point is needed, and one that should act downward. I started to work upward, with the idea that if bricklayers could be induced to make themselves fit, they would be sure to receive encouragement and assistance from above. I appeal, not only to members, but to clerks of works generally, in full confidence in their ability, to take up this question in the spirit its importance demands. I never yet saw a clerk of works who did not take an especial interest in woodwork of whatever description and character, or show a commendable anxiety in regard to masonry, ironwork, and concrete, etc. But we seldom meet with one who has a habit of getting very enthusiastic about brickwork, or takes any great pains (using a homely expression) to look through a brick wall. Now, he who would look through a brick wall should have eyes trained to the purpose. In other words, those who are called upon to supervise brickwork in execution should know something about it, both technically and practically, and moreover keep a watchful eye over it. The very nature of its construction demands a watchfulness peculiar to itself, seeing that every one course of bricks hides everything, good or bad, appertaining to the one beneath it.

The key, or as I may say the A B C, to properly constructed brickwork is the perfectness of the bond; and in proportion to the correctness with which the bonding is carried out, so is the strength of the wall—that is plain. It is possible—indeed, it is practicable—to construct a mass of brickwork, no matter how extensive or intricate in character—so long as it is in conformity with the technical laws which regulate the thickness of the walls in bricks and half bricks according to the strength required—as perfect in its bond as a fabric of cloth which is woven without a false stitch.

Now, the most incompetent bricklayer is fully alive to the necessity of bonding on the face of a wall, it being considered an unpardonable fault, if be is caught, even in the most rough description of work, with the bricks so placed that a vertical joint in one course is brought directly over a similar joint in the course immediately beneath it, technically known as a "straight joint." It is also a poor workman who is not aware of the importance of preserving, or at least some attempt to preserve, in fairly good face work, a plumb-line with the perpends; that is to say, that every brick as placed in the first course, should keep the same position in every course alternately, in a direct vertical line to the top of the wall.

Again, a fairly skillful and intelligent bricklayer knows, and he is not skillful if he does not know, that in setting out the position of the bricks in the first course of a wall (if it is to be face work), the several features in the elevation upward should be taken into account, so as to obviate any change in the perpends as the work proceeds; and all, skillful or unskillful, can distinguish the difference between what is known as "Flemish bond" and so-called "old English bond;" but beyond these matters few ever trouble themselves in regard to bonding.

To produce perfect bond it is necessary that every brick or half brick should occupy on the inner face of a wall a position identical with those on the outer face, and the middle, when the thickness is sufficient to justify the term, should follow, brick for brick, the two faces, but it is the rarest thing imaginable to find it so, or even so, it is more than likely the result of chance rather than from careful foresight or judgment. We often hear a deal of talk about Flemish bond as applied to face brickwork.

I don't know how it is that this system is so frequently adopted by architects; of this I am certain, that did they know but a tithe of what I could tell them of the disreputable practices to which it gives rise in respect to the inner section of a wall, it would not be so frequently provided for in their specifications. Even at its best it is a defective arrangement, for beyond the face half brick, perfect bonding is impossible. And if, as it only too often happens, the face is unskillfully treated, permanent disfigurement is inevitable, a horrid example of which may be seen in the case of a new building of no mean pretensions, now nearly completed in the neighborhood of Bloomsbury.

There is a system, or rather no system, in bonding of which I have heard, and had it described to me as being in common practice in the manufacturing districts, and in, I believe, some parts of America, where, to dispense with outside scaffolding, the bricklayers stand, or partly so, on the wall, and lay the face courses over hand; for convenience of standing and reaching over, and also to facilitate rapid progress, a certain number of stretching courses are laid on the face successively, say three, four, or five, as may be, and when the remainder of the thickness of the wall is leveled up to the top of these, a "thruff," as it is called, which means a bonding course of headers, is run through, and then the stretchers are laid as before.

A specimen of this kind of bonding may be seen in the case of the large pile of buildings situated at the rear of the new Law Courts, the whole of the walls of which are systematically made up with three consecutive courses of stretchers to one course of headers; so that in every foot in height there is but one bonding course only instead of two. I need scarcely say this method, whatever reason may be assigned for its adoption, is diametrically opposed to the fundamental principles of brickwork. Similar results follow where, as it sometimes occurs, the facings are purposely made of a different thickness to the bricks provided for the body of the walls.

There are many examples of such work to be seen; in one prominent special public building five courses of these facings measure a foot in height only, while the bricks for the backing are of the ordinary kind, and rise a foot in four

courses. Thus it will be seen that in the absence of some fluke no lateral tie or bonding can occur other than one to each foot, or one in three of the heading courses. Now, suppose in such work heavy projections are thrown out, the leverage would naturally act upon the facing bricks as a fulcrum, and have a tendency to tear them away from the mass.

To any one accustomed to look through a brick wall it is impossible to look upon such work as this without a certain amount of humiliation, because he must know that in those courses of heading bricks, which to less practiced eyes appear to fulfill their legitimate purpose, two out of every three cannot be otherwise than a mere sham. Nor is that all, for he will not fail to see that in the case of the actual bonding course, the width of the face-headers being 5 in. as against 4½ in.—the width of those in the interior—the former will overrun the latter, thereby destroying the regular methodical quarter brick lap peculiar to perfect bonding. Again, the length of the bonding headers—10 in. as against 9 in.—necessitates wider walls to provide room for this extra length. The additional width not being required for the intervening courses, involves an extra expenditure of mortar to fill up the superfluous space.

I will now describe to you what is meant by perfect bonding. This becomes possible only by adopting the system known as "old English bond," presumably so called because it originated with the early English bricklayers. But by whatever name it is called, it is the one and only method by which brickwork can be made perfect. Not so very long ago, when describing this system, an old bricklayer who was present seemingly could not at first quite understand what was meant; but when eventually he caught the idea, he rather contemptuously remarked, "Ah, I see; you mean 'navvy bond,'" owing, I suppose, to the fact that it was invariably adopted on railway works, engineers at least being fully alive to its value in regard to strength, although it is open to doubt if even they ever succeeded in obtaining, beyond the face courses of their brickwork, any more perfect bonding than other people.

It will, perhaps, appear to you something like a paradox when I tell you that this apparently mysterious matter, about which you have heard so much, is in reality no mystery at all, as I will show you; or rather, I might say, if there is anything mysterious about it, it is to be found in the fact that it is so seldom any heed is taken of it. It simply consists of a method of so placing the bricks, as I stated before, on both faces of a wall, in such a position that each brick or portion of a brick on each face shall correspond with the other, and those in the inner section to conform to those on both faces.

Thus it will be plainly seen, if this rule is strictly followed—and there is nothing but the will to hinder it—that in exact proportion as the face bond is technically and practically correct, so will be the perfection of the bond in section. Under these conditions it is immaterial what is the thickness or variations in thickness of the wall or walls; so long as they are made up of whole bricks or halves in the usual way, the bonding is certain to work out correctly in all cases. When it occurs that the thickness of a wall contains an odd half brick—for instance, a one and half, two and half bricks, and so on—the odd half must be kept on the face. Thus one side of the wall will be stretching, the other heading courses, alternately.

This rule, so far as the face is concerned, is generally understood; but it is in such cases where, as regards the bond in section, the greatest irregularity prevails, because the majority of bricklayers insist that the angles, or quoins, which give the cue to the general face, must be set out in all cases alike. Thus it happens in these particular instances, nine out of every ten are set out wrongly, and the error committed at the quoin is perpetuated along the whole length of the wall, with this result—the middle consists of so many bricks or half bricks piled up course upon course, one lying immediately on the other without any bonding whatever other than across the wall.

There is a small but well known feature in brickwork which is the subject of a vast amount of controversy among those who are ignorant of the important part it plays in the matter of bonding. This is technically known as the "closer," and it is the key to the whole system. Its place is next the angle header, and its presence gives rise to the systematic lap of one brick over and under another, as seen on the face of all brickwork, and supplies the name "bond." The closer should in all cases be continued throughout the full thickness of the wall on the face of which it occurs in each alternate course. Failing in this, which is more often the case than not, the bond in the quoin is imperfect. There are some who object to these "little bricks," as they sarcastically describe them, and positively forbid their use, with the inevitable consequence of broken and imperfect work, to say nothing of disfigurement on the face.

A striking instance I noticed the other day in the case of a rubbed and gauged brick front, having at each extremity an 18 inch or two-brick pilaster, in which a stretcher is made to fill the place of the usual headers and closers, in the same way as in a hollow pier or chimney flue, for which it might easily be mistaken. This, I was told by the workman who built it, was insisted upon by the architect, evidently showing that he sacrificed symmetry and integrity to a distaste for those "little bricks."

This sort of thing, happily of rare occurrence on the exterior face of a building, may be seen daily in the case of piers, pilasters, or jambs, in connection with the interior, where, to a certain extent, it is to be hidden up. This arises partly from ignorance of the importance of proper bond as an element of strength, and partly from the cupidity of foremen or sub-contractors, as the case may be, who are too apt to leave out of consideration everything possible which, in their idea, has a tendency to impede rapidity of progress, and this even in cases where strength is of vital importance. Picture to yourself a pier or jamb, designed to receive the end of a girder carrying a heavy load, and resting upon it say a foot or less, and this pier built up with an outer casing of a half brick thick, having no connection by bonding with the inner section.

Bricklayers, as a rule, will plead as an excuse for bad bonding, that they are not allowed the time to take proper heed of it. But in a certain sense only is that true; because it absorbs the same amount of time and labor to pick up a brick in whatever position it is afterward to be placed; and in many especial cases where imperfect bond is the most likely to prevail—for example, filling in the section of a wall or pier—it only amounts to whether a brick shall be placed 2¼ inches to the right hand or the left. Again, in regard to "bats" or broken bricks, we know that so long as we have bricks, so it is certain we shall have more or less a proportion of bats, especially nowadays, on account of the disreputable manner in which they (the bricks) are handled in transit from the kiln to the building, and in these days of competition must and will, in spite of remonstrance, be used. But instead of being bundled into the walls indiscriminately, they should be carefully distributed, and if placed in proper form in the same position as whole bricks, the bond lengthways of the wall will be the same as if they were whole, and across the wall the defective bonding will be to a certain extent mitigated.

It may be urged, in reference to this matter, what necessity can there be for any fuss about it? We have got on all these years very well without it; our brick buildings don't, as a rule, fall to pieces. Brick walls are brick walls—what more is needed? I reply, so in the same way a door would be a door, even though its stiles were cut in between the rails, and the muntins run through. But a man that made such a monstrosity would be unanimously voted an ignoramus. Brickwork is brickwork, in the fullest sense of the word, only when it is constructed upon those true principles of bonding which I have endeavored, however imperfectly, to explain to you in this paper; and should I succeed through it in directing the attention of the members of this association toward the subject with that earnestness its importance demands, then I shall have made another step toward the object I for years have had in view.

SUGGESTIONS IN DECORATIVE ART.—CHAIRS FROM THE COLLECTION IN THE LOUVRE, PARIS. (FLEMISH RENAISSANCE.)

CRYSTALS FROM SLOW COMBUSTION OF ETHER.

THE peculiarly penetrating odor produced by the slow combustion of ether has been examined by Legler. From 150 to 200 c. c. of ether, 25 to 30 c. c. of the crude product was obtained. This exposed for ten days over sulphuric acid gave crystals in rhombic prisms resembling ice flowers, soluble in water, alcohol, ether, and chloroform, fusing at 51°, neutral in reaction and affording on analysis numbers leading to the formula $C_{11}H_{22}O_{11}$. With alkalies it evolves hydrogen, formic acid, and methyl aldehyde. With ammonia, it gives oxygen with the other bodies.—*Liebig Ann.*

RECOVERING SILVER FROM WASTE GELATINE EMULSION PLATES OR PAPER.

By J. PIKE.*

THE plan I pursued and have followed with success is briefly as follows, and the operations are all such as you are familiar with: Supposing that you have a pint or so of fogged or defective emulsion; melt this, and pour into one or two shallow porcelain dishes. Allow it to set, and then pour on a solution of hyposulphite of soda (four ounces to the pint), sufficient to cover. In a short time the film, previously opaque, will be found quite clear and transparent; the film has become, in fact, what photographers call "fixed." The hypo. solution has dissolved out all the bromide, iodide, or chloride of silver in the emulsion. The waste plates are treated much in the same way. I have a box capable of holding about two dozen plates. I fill it, and pour on sufficient hypo. solution to cover. Very soon the plates are all quite clear, and they may then be removed and cleaned; if not allowed to dry, they will be cleaned very easily. It is quite unnecessary to throw away any particle of emulsion or any piece of coated glass or paper. All articles, such as bottles, dishes, funnels, etc., used in the process of manipulation, are easily and rapidly cleaned with warm hypo. solution, and I can say that if done soon after use, the effect is magical. Any amateur who makes his own plates will know and appreciate the value of all this.

All these hypo. solutions and washings are mixed together in a large bottle, and a sufficient quantity of a solution of ammonium sulphide or potassium sulphide is added to cause the whole to smell strongly; precipitation of the silver as sulphide proceeds at once, and when quite settled at the bottom of the vessel, the supernatant fluid may be poured off, but not necessarily thrown away. The remaining thick liquid should be poured into a filter, the precipitate drained, washed, and dried, and it may now be mixed with half its weight of carbonate of soda and fused in a crucible. If sufficient heat be applied, a button of silver will be the result; if not, the silver will be found as oxide contaminated with soda. The brownish colored mass may be powdered, washed with water to free it from soda salt, and dissolved in dilute nitric acid. This solution is boiled to get rid of excess of acid, and then allowed to cool and crystallize. Personally, I prefer to keep the nitrate of silver in solution, test with the argentimeter for strength, then convert into bromide with ammonium bromide, and emulsify.

It has been suggested to me that the gelatine recovered from the waste emulsion is not worth saving. I do not agree with this. If properly treated I see no reason why, provided the sample be a good one, it may not be used for a fresh batch; if not, there are other uses to which it could be put.

Those who may object to a few even simple operations may keep their silver waste as sulphide until they have sufficient to send to a refiner. In any case I consider, as matters are, the waste of even a single plate inexcusable.

Other solutions used in the various processes of our art are also worth saving. For instance, the waste pyrogallic developer, to which a small quantity of saturated sulphate of iron solution has been added, makes a capital writing ink, as the fact that this paper is written with such ink proves. It may be a little thin, but that is a fault easily remedied.

RESISTANCE OF COTTON TO HIGH TEMPERATURES.

THE Chemical Committee of *The Société Industrielle de Mulhouse* has been experimenting on the effect of high temperatures on the strength of cotton fiber. Members of the society had observed, that when cotton cloth was, preparatory to printing, passed over the singeing machine, the chain sometimes became weakened while the filling preserved its strength, and this without either showing a change of color. The temperature to which cotton could be raised without losing any of its power to resist tensile strain, as well as the effects of temperatures yet higher upon that power, were seen to be important practical questions, and these the committee undertook to solve.

DRY HEAT.

In order to do so they selected samples of cotton cloth, similar in size, tested the strength of both chain and filling by the dynamometer, placed each sample in a copper can, and subjected it to temperatures of 100°, 150°, 180°, and 210° C., by plunging the can first into a bath of boiling water, then into one of oil, and finally into one of paraffine, the temperatures being accurately determined by a thermometer which passed through the lid into the body of the can. Six samples each of six different makes of goods were thus tested. The results were not entirely uniform. Nor is uniformity to be expected where yarns are not perfectly homogeneous. The tests, however, prove that up to 150° C. the fiber is not weakened, although, if the time of the experiment be prolonged, there is a slight darkening of the shade. At 180° C. the darkening is increased and the weakening becomes marked. At 210° C. the fiber begins to turn brown, and the tenacity is reduced to but one-third, sometimes but one-fourth, of what it was before the experiment.

Even when prolonged for eight hours, a temperature of 150° C. is without effect, while if the temperature during that time be 10 degrees higher, cotton becomes sensibly more tender. 160° C. may, therefore, be considered the critical or danger-point in the treatment of the fiber, and this whether the treatment be dry or moist. Cotton which, before being heated, bore a traction represented by the figure 10, broke with 17 when kept for one hour at 170° C.; with 15 when thus heated for two hours; with 13 when heated for four hours; and with 8¾ when heated for eight hours.

The temperature actually acquired by the cotton during a passage, say of a quarter of a second, through the naked gas flame of a singeing machine, can with difficulty be determined. Experiments were, therefore, made in a bath of melting tin at its point of fusion, 228° C., the fiber being wound round an iron wire and retained in the bath for a half second, and again for a second. In neither case was the strength of the fiber affected. A similar experiment made with a bath of melted lead at a temperature of 350° C. produced but little if any effect. The period was too short to induce the chemical change in the cotton which much lower temperatures make when prolonged.

SUPERHEATED WATER.

A very instructive experiment of Senarmont is cited to show that the weakening of the fiber may be due to deby-

* Read before the Newcastle-on-Tyne and Northern Counties' Photographic Association.

dration, although it must be confessed that the cases are not exactly parallel. If, in dyeing, we first pass the cotton cloth through a solution of a salt of iron, and then through a bath of carbonate of soda, we develop the brown tint of the rust of iron. If, now, we boil the piece of goods in water under pressure, say at a temperature of 150° C., the shade becomes redder and darker, acids attack the dye with difficulty, and it is no longer susceptible of being colored blue by the prussiate of potassa. The oxide of iron, dehydrated by the high temperature, not only resists these chemical influences; it loses its adhesion for the fiber, and falls off as dust when the goods are beaten. The dehydration of the oxide of iron took place in the superheated water, and a similar change may, it is claimed, occur in cotton fiber under the same conditions. Accordingly a steam-tight copper can was obtained, into which a sample of goods similar to those subjected to dry heat was placed, covered with water, the cap securely fastened, and heat applied. At a temperature of 150° C., even when maintained for eight hours, no appreciable reduction in the strength of the fiber took place. At 160° C., similarly maintained, the strength fell from 19 to 14, and at 170° C. the weakening was, of course, greater.

SUPERHEATED DYE-STUFFS.

The *Société Industrielle de Rouen* has, through one of its members, M. Scheurer, been giving attention to the effect of certain salts used in dyeing upon the cotton fiber, to which they become attached in the vat, when they are subsequently dried at a high temperature. The goods tested were soaked in the solution, wrung out, dried, and then subjected to dry heat.

Chloride of zinc, even in a weak solution, caused a sensible weakening of the fiber when the sample was exposed for an hour to a temperature of 110° C. When the solution contained 50 grammes of the salt per liter, the sample was entirely destroyed.

Chloride of calcium, in the proportion of 10 grammes per liter, below 130° C. did not sensibly attack the fiber. At 140° C. the weakening was manifest, but the action did not appear to increase in energy when the strength of the solution was raised to 50 grammes per liter. Time as before, one hour.

Chloride of magnesium, 50 grammes to the liter, began to attack the tissue between 110° and 120° C. When the solution was reduced to 10 grammes per liter, the injurious effects were not sensible until 130° C. was reached.

Mixture of chloride of zinc and chloride of calcium. The effect of adding a solution of chloride of calcium to that of chloride of zinc, the proportion of the salt in the latter being the same, is very sensibly to reduce its corrosive action.

Mixture of chloride of zinc and chloride of magnesium. The action of the mixture is also much less violent than if the chloride of zinc is used alone.

Sulphate of zinc causes an action sensibly destructive at 120° C., and the action appears to be in proportion to the strength of the solution.

Sulphate of magnesia gives results not very decided. Its action does not become sensible below 140° C.

Mixture of chloride of zinc and sulphate of zinc. The action of this mixture is more feeble than that of the chloride alone.

Mixture of sulphide and chloride of magnesium. Action quite as weak as that of the pure chloride.

The violence of the action of the chlorides of zinc and magnesium should cause the exclusion of those salts from all tissues to be passed over the singeing machine, or to be otherwise exposed to high temperatures. The existence of the injury, probably not observed at the time, would be sure to make itself manifest afterward.

SINGEING HEAT.

As attempts to ascertain directly the temperature to which the fabric is raised, when passing over the flame of the singeing machine, have not proved successful, indirect methods have been sought, and the following solution has been employed: Water, 1,250 parts; tartaric acid, 90 parts; chlorate potassa, 43 parts; aniline, 150 parts; ferricyanide potassium, 53 parts. When cotton cloth dyed with this solution is heated to 80° C., it instantly becomes green. Raise the temperature to 100° C., and the color is changed to black; to between 120° C. and 130° C., and it is browned, and the dye-stuffs reduce the strength of the fabric used. The change of color is therefore an approximate measure of the temperature, and goods thus dyed have been used as thermometers in experiments with singeing machines. In no case when working in the regular way has a temperature above 100° C. been found to be imparted to the fabric. The test-pieces become black, but never, except by accident, brown, and it may be affirmed that, when properly managed, none of the singeing machines in general use raise the cotton fabric to a temperature which it cannot bear without injury to its durability.

THE USE OF BUTTER, MILK, AND MAMMARY TISSUE IN THE MANUFACTURE OF BUTTERINE.*

By C. MEYMOTT TIDY, M.B., F.C.S., AND G. W. WIGNER, F.C.S., F.I.C.

ALTHOUGH the manufacture of butterine is very little understood in this country, it is not our purpose to enter at all into the details of the manufacture, or to explain them in any way, but only to point out one or two facts which have come to our knowledge, and which have considerable chemical interest.

It has, hitherto, been a common error to suppose that it was impossible to mix butter with butterine, and this has no doubt led to mistakes in adulteration certificates from which we should apprehend that few public analysts have been free. It is quite likely that we ourselves have not been so.

The process of butterine manufacture is now conducted in such a way that there is no difficulty whatever in mixing any desired percentage of butter with the oleomargarine, which is the raw product—and it is just as easy to obtain a butterine containing 50 per cent. of true butter as one containing 1 per cent.

The manufacture of butterine appears to have been started about the year 1869, and the description of the process contained in the patent taken out then appears to us to show clearly two things—first, that the inventor Mege was, so to speak, ahead of his time, as regards what he saw as the future of his invention; and, secondly, that he had the idea in his mind of some chemical changes occurring in the fat under certain conditions, to which we will refer, but which, up to the present moment, have never been experimented upon by any chemists except ourselves.

The point to which we specially wish to draw attention now is the action of mammary tissue on fat. Mammary tissue in its crude form may, of course, be taken to mean simply the chopped up udder of a cow, but it occurred to us, and the experiments show that we were right in our supposition, that this mammary tissue may also be contained in milk and in butter. We have made a good deal of inquiry on the subject, and as the result of this we are convinced that butterine is never made without the admixture of some portion, and usually a very considerable portion, of milk and butter, or either one or other of these ingredients during the process.

The oleomargarine, pure and simple, which is the raw material of butterine, is simply purified suet, and as far as we have seen it is prepared with great care, melted at a low temperature so as to avoid any burning, which might produce a tallowy smell, and then sufficiently cooled to allow of the extraction by means of pressure of the excess of stearine which it contains. The more fluid part, containing the larger proportion of oleine, is used for the subsequent manufacture of the butterine.

This raw material, *i. e.*, oleomargarine, is being made at the present time by a number of manufacturers in this country and abroad, and in fact the greater part of what is made here is being exported for further manipulation abroad, so as to make it into finished butterine, and export it again to this country as a more valuable article.

The next process is to bring the fat into what is considered a different condition, and according to the experiments which we have recently tried, the process is certainly successful. It was proposed to treat the fat with mammary tissue for some few hours at animal heat, and we find that such a treatment as this does specifically alter the character of the fat, and that, as the result, an altered fat is obtained, which, even if it does not resemble butter, has at any rate been changed in character, so that it is not the pure oleomargarine fat that it was before.

We have repeatedly tried the experiment, and having taken pure animal fat, *i. e.*, melted suet, and digested it with the chopped-up udder of a cow, for from three to six hours, we have found that a definite and marked chemical change in the composition of the fat was produced. This point appeared to us to open up a new field of inquiry, viz., to see whether it was really possible that the udder of a cow after death did contain any ferment or other substance analogous (we will say) to pancreatine or pepsine, but which, differing from them, might at any rate have some anomalous effect upon fat, so as to insure its digestion, or so as to change it in any way.

Obviously, it is desirable in carrying out an investigation of this kind that the udder of the cow with which the experiments are tried should be obtained from an animal which is in full lactation, and treated immediately after the cow has been killed. Up to the present we have not been able strictly follow out this course, but we have obtained some certain results which are sufficient as serving to throw some light upon the matter, and we intend to carry it further. We took portions of the udders of cows, and extracted from them with dilute alcohol certain substances which proved on evaporation *in vacuo* to contain as least three different constituents. One of the three is a fatty body of a peculiar kind which needs further examination, and that examination must obviously present circumstances of special difficulty, which will be the more readily appreciated when we say that it appears, as far as we can see from preliminary experiments, to differ in several points both from oleomargarine and butter.

We also obtained two other products, but cannot report fully upon either of these at present. This much, however, has been found out—that one of them has a definite action upon fats, which action is of such a character that it changes the fat by altering its sp. gr., or actual density, and by producing a certain although small amount of volatile fatty acids from the fat, which previously contained nothing but insoluble fatty acids.

We have tried a number of experiments with mammary tissue, and with the extracts taken from the fresh udder; but, as far as we have gone, we find that, practically, there is no difference between the effect of the two.

Oleomargarine, or tallow, is in either case changed to a certain extent, and both soluble and volatile fatty acids are formed, instead of the insoluble fatty acids which were the only ones present before.

It follows from these experiments: first, that the chemical result which has been obtained so far is that the udder of the cow contains a certain substance or substances which are capable of acting upon fat, and which do by that action change its chemical composition. Secondly, that the same results can be produced by using an extract obtained from the udder of a cow.

But our experiments led us to go further even than this. Butter and milk both contain sensible proportions of mammary tissue in the shape of casts from the mammary glands, and they may, for aught we know to the contrary, and probably do, contain other matters which are not easily recognizable by microscopical examination, but which yet may be present in sufficient proportion to exert a definite physiological action, and from certain of our experiments we are inclined to think that this is the case.

Thus far, we are satisfied that both milk and butter do, to a certain limited extent, produce the same effect as we have already ascribed to mammary tissue. The action of milk so far as we can judge at present is small, but it appears to result in the increase of the soluble fatty acids to a definite extent, which is quite sufficient to be capable of estimation. The action of butter is greater, perhaps, because it contains a larger proportion of substances derived from the mammæ of the cow, but it appears identical in character with the action of milk. This viewed from a chemical standpoint may mean solely that the milk when it passes into the udder of the cow does not contain butyric acid, but that butyric acid is generated entirely in the lacteal glands.

We have put this forward simply as a view which may or may not be upheld by subsequent investigations, but still the probability of the fact being as we state is quite sufficient to justify its being mentioned.—*The Analyst.*

* Read before the Society of Public Analysts, May 30, 1883.

FREEZING POINT OF ACID SOLUTIONS.

THE author gives tables of the lowering of the freezing point occasioned by adding 1 grm. of various acids to 100 grms. of water. He has established that the sulphurous, iodic, phosphorous, arsenious, and arsenic acids are almost entirely expelled from their alkaline salts in dilute solutions by a quantity of hydrochloric or nitric acid sufficient to saturate the base.—*F. M. Raoult.*

SULPHUR.*

By CHARLES EHRMANN.

SULPHUR is an element well known for its great importance to the chemical and technical industries of the whole civilized world. It is the base of sulphuric acid, a factor without which all industrial efforts would come to a complete stoppage. When in the year 1841 the Government of Naples laid an export duty on sulphur, manufacturing England answered this measure with a declaration of war. And justly so. All the efforts of the chemist to produce sulphur from pyrites and sulphurets could not satisfy the demand for it. Without sulphur there cannot be any sulphuric acid, no muriatic acid, no chloride of lime, soap, soda, glass, etc. Even warlike powers would be condemned to everlasting peace for the want of gunpowder.

Sulphur is disseminated throughout the mineral kingdom—it occurs in the earth native or in combinations. When native, it is found either in translucent or opaque masses, or in a powdery state mixed with limestone, gypsum, slate, etc. In its purest form it is found in Italy, Sicily, Galicia, California (Santa Barbara), and many other places. In combination it occurs almost everywhere with iron, lead, mercury, arsenic, antimony, copper, and zinc, forming compounds called sulphurets. More extensively we find sulphur as sulphates, which as sulphate of calcium, barium, and other metallic bases constitute enormous mountainous masses. Sulphate of sodium is a companion of the chloride of sodium of sea water, and sulphates enter the organism of animals and plants. All proteine matter—albumen, glutin, casein—always contains sulphur. A full grown man is said to carry in his body four ounces of it.

Sulphur is a non-metallic element; it is brittle, solid, pale yellow in color, of crystalline texture and shining fracture. Its symbol is S, eq. number 16, and density 2. It is insoluble in water, but soluble in alkaline solutions, petroleum, naphtha, fixed and volatile oils, alcohol, ether, chloroform, and bisulphuret of carbon. Sulphur melts at 115·5 deg. C., and when cooling will under circumstances crystallize in sharp, slender prisms. The crystals formed from a solution of bisulphuret of carbon are octahedric.

Sulphur heated to 150 deg. C. ignites, and enters easily into combination with oxygen, metals, and other elements, some of which are very important to the photographer. Of all of these, let us first consider the well known

Sulphuret of Potassium, which is formed when carbonate of potash and sulphur in certain proportions are brought to a state of tranquil fusion and allowed to cool. The mass obtained is hard and brittle, of peculiar taste and odor, and of a liver brown color. Hence its ancient name of *hepar sulphuris*. It is easily soluble in water, attracts oxygen by exposure to air, and changes gradually into potassium sulphate, when it becomes inodorous and white on the surface. The solution is decomposed by mineral acids, which liberate sulphureted hydrogen and precipitate sulphur. Most of the metals in solutions are by it precipitated as sulphurets. Hence its use to throw down silver as a sulphuret of silver from old fixing baths or other solutions containing it, and as an intensifier for negatives,

Sulphuret of Ammonium is used for similar purposes. It is made by passing a continuous stream of sulphureted hydrogen through liquid ammonia till saturated.

Sulphuret of Antimony and Sodium, or Schlippe's Salt, is also used as an intensifier, often in combination with bichloride of mercury. It consists of large, pale yellow diaphanous tetrahedric crystals. It should not be used when the crystals are covered with a reddish brown surface.

Sulphureted Hydrogen is used as a reagent for the detection of metals. It is obtained by the action of sulphuric acid upon sulphuret of iron. The gas thus set free is either applied direct or when mixed with water.

Some of the combinations of sulphur with oxygen are of the greatest importance. Besides sulphurous acid, SO_2, and sulphuric acid, $S+O_3$, there are known a series of others. Dithionous acid, S_2O_2; dithionic acid, S_2O_5; trithionic acid, S_3O_5; tetrathionic, S_4O_5; pentathionic, S_5O_5; to all of which the photographer's interest need only be directed to the dithionous or hyposulphurous, the sulphurous, and sulphuric acids.

Hyposulphurous Acid, S_2O_2, is formed by heating a soluble sulphite with sulphur, or by the action of sulphuric acid upon metallic zinc and sulphite of zinc. This acid exists in combination only, and has not yet been prepared in its free state. Combined with soda it forms the widely known hyposulphite of soda or fixing soda. This salt is readily made by mixing dry carbonate of soda with powdered sulphur, heating the mixture till the sulphur melts, and stirring the agglutinated mass to bring every particle of it in contact with the air. The sulphuret of sodium first formed is thus converted into sulphite of soda. This is dissolved in water, and the filtered solution being boiled with sulphur becomes sulphite, which salt will deposit in crystals. During the process the sulphuric acid of the sulphite takes up an additional equivalent of sulphur, becoming hyposulphurous or dithionous acid, which forms with the soda hyposulphate of soda. This salt is obtained as a by-product in very large quantities, and at enormously low prices, in the manufacture of soda, of which I will tell you particularly some other time. The solutions of hyposulphite of soda dissolve all insoluble silver compounds except the sulphuret and that resulting from the decomposition of a silver salt by light. It dissolves iodine, and forms with it iodide of sodium and tetrathionate of soda and the blue color of iodide of starch. The photographer uses it to dissolve the silver haloids on plates or paper not acted upon by light; and it is also used as a bleacher in many instances. Its chief use, however, is for the destruction of chlorine when it has been applied to destroy the color of paper pulp or fabrics. Therefore it is known in commerce by the name of antichlor. It converts the chlorine into hydrochloric acid, which forms with the soda chloride of sodium, and the hyposulphite of soda is changed to neutral sulphate of soda; either of these substances remaining in the paper of which mounts are manufactured is not injurious to the photograph pasted upon it.

Sulphurous Acid, SO_2, occurs occasionally in volcanic exhalations of gases, but is formed directly by burning sulphur in atmospheric air or oxygen. At the ordinary temperature the acid is gaseous, colorless, and irrespirable, and of the well known suffocating odor of burning sulphur. It is soluble in water, forming the so-called aqueous sulphurous acid. The great energy of this acid to attract oxygen and form with it sulphuric acid is proved by its application to prevent putrefaction and fermentation. The so-called sulphuring of wine and cider casks has been carried on for centuries to retard the fermentation and acidification of those liquids. Another peculiar property of sulphurous acid is its power to

* Read before the Association of Operative Photographers of New York.—*Photographic Times.*

decolorize many pigments. Its use is, however, restricted to the bleaching of animal matter, as wool, silk, feathers, leather, etc., the colors of which are not easily attacked by chlorine, being oftentimes even intensified. Sulphurous acid and sulphite of soda, added to the pyrogallic developer used for gelatine emulsion plates, have of late been introduced into the photographer's laboratory. Without attempting now to discuss the merits of these additions, it is nevertheless evident that the sulphite of soda prevents, from its properties mentioned above, the decomposition of the pyrogallol. It is further claimed that it gives to the negatives the tone and color so much admired in a collodion plate. Mr. Berkeley, of England, was probably the first to recommend these accessories to the photographer.

Sulphuric Acid, $S+O_3$, is absolutely indispensable in the pursuit of all technical and chemical operations. It is one of the most powerful factors of modern industry, and is one of the strongest and also one of the cheapest acids known to commerce and the chemist. Whenever weaker acids must be separated or expelled, alkalies neutralized, metals or metallic oxides converted into corresponding salts, it is invariably employed. Its manifold applications are equaled only by its enormous consumption. To manufacture sulphuric acid, sulphurous acid is first generated by burning sulphur in atmospheric air, and its higher oxidation promoted by means of nitric acid. We have seen how easily and energetically sulphurous acid takes up oxygen from all matter containing it. If sulphur is oxidized with even pure oxygen, it will only yield sulphurous acid, but becomes sulphuric acid by subsequent contact with other oxygenous matter. Of all means to oxidize sulphurous acid, nitric acid is by far the most practical and economical. Nitric acid, NO_5, is a combination of 1 eq. (or 14 parts) of nitrogen and 5 eq. (or 40 parts) of oxygen. If 2 eq. of sulphurous acid come in contact with NO_5, each one of these will take up 1 eq. of oxygen, thus forming 2 eq. of sulphuric acid, while nitrous acid, NO_3, a reddish brown gas is liberated. Further, when 3 eq. of nitrous acid, which are equal to 3 nitrogen and 9 oxygen collectively, are brought in contact with an abundance of water, they are decomposed into 1 eq. of nitric acid, NO_5, and 2 eq. of oxide of nitrogen, NO_2; this gas is analogous to sulphurous acid. On combining with oxygen it is immediately changed to nitrous acid, NO_3, which again is converted by the water present into nitric acid and oxide of nitrogen, and so on *ad infinitum*. Sulphuric acid is manufactured on a large scale within a system of large leaden chambers, into which the vapors of sulphurous acid are carried and brought in contact with finely divided sprays of nitric acid. The acid formed is collected at the bottoms of the chambers and contains then about 66 per cent. of pure hydrated sulphuric acid, a rectification of which is completed in a platinum still. The article thus obtained is commercial sulphuric acid of from 97 to 98 per cent. The photographer uses pure sulphuric acid for various purposes. To make guncotton, either in combination with nitric acid or with nitrate of potash; to clean glasses, using either the pure acid or when mixed with nitric acid or bichromate of potash; to destroy the viscosity of glutin, when it is necessary to recover the silver from useless bromo-emulsions; as an addition to protosulphate of iron solution to prevent its oxidation, etc.

Of the sulphates we handle daily, let us mention alum, or sulphate of alumina and potash, for hardening gelatine negatives; chrome alum as a substratum for gelatine plates; sulphate of copper for various intensifiers; sulphate of iron and sulphate of iron and ammonia, the principal agent for the making of collodion negatives and positives, and again for the production of ferrous oxalate developer; sulphate of potash, as an admixture to ferrotype developer; sulphate of magnesia to arrest frilling and puckering of gelatine plates; sulphate of uranium with prussiate of potash as an intensifier, etc.

Sulphur and many of its combinations, you will thus observe, are of great importance to us as well as to most all other trades or manufactures. Sulphuric acid is instrumental to furnish mankind with all possible necessities, comforts, and commodities, for it is used in producing them all and it is well to say: The state of industry of a country must be rated at her consumption of sulphuric acid.

NEW COLOR REACTIONS OF THE ALKALOIDS.*

By B. ARNOLD.

THE author describes the behavior of various alkaloids with certain reagents; the most distinctive are the following:

Conine.—One drop, when mixed with a few drops of sirupy phosphoric acid, and the mixture evaporated in a white porcelain capsule over a small flame, becomes a fine green to blue green.

Nicotine similarly treated gives a deep yellow to orange, the residue is soluble in water; the same color. The reaction is more surely obtained when the mixture is heated for five to ten minutes on the water-bath. Conine when so heated shows a clearer green.

Aconitine.—The well-known violet color given by this alkaloid when evaporated with phosphoric acid is obtained easily and surely by agitating a few particles with sirupy phosphoric acid and warming ten to fifteen minutes on the water-bath.

The sirupy acid used as the reagent is obtained by dissolving the anhydride or the glacial acid in the officinal phosphoric acid of the German Pharmacopœia.

The author suggests that the ptomaconine of Selmi should be tested by this reagent.

Portions of other alkaloids yielded characteristic reactions when rubbed with a few drops of concentrated sulphuric acid and gently warmed; alcoholic or aqueous potash solution (30 to 40 per cent.) is then dropped in by means of a capillary tube with constant stirring until in excess. Narcotine, morphine, and codeine give the most striking reactions.

Narcotine, in course of heating with the acid, takes a yellow, or, if warmed longer, a violet color. On the addition of alcoholic potash, it becomes a fine orange-red, which on adding water passes to yellow; treated with *aqueous* potash solution, the final reaction shows a gamboge-yellow, soluble, unchanged in water.

Morphine on the addition of the alcoholic solution becomes yellowish to dirty red, then turns to steel-blue and sky-blue. The continued addition of the potash solution causes, after a short time, a transition to a fine cherry-red. Water partially dissolves the residue to a red-violet color; the residue is a fine blue to blue-green, and dissolves with that color on adding water. Treated with *aqueous* potash solution it passes from red to a fine moss green, and on further addition of the potash solution to a dirty yellow-brown. The more strongly the morphine is heated with the acid, the more intense is the blue produced on the addition of alcoholic potash.

Codeine gives no reaction with alcoholic potash; with the aqueous solution it passes from reddish to pure green, and then to a dirty white; if it is heated with sulphuric acid until it begins to brown, it gives all the reactions of morphine, and seems to change into that body.

Solanine with the alcoholic solution passes from yellow to blue or red-violet, particularly after standing some time; with more potash it becomes whitish-gray. Sulphuric acid dropped into the mixture to excess causes a cherry-red, which disappears on adding water. Solanine treated with the aqueous potash solution passes from yellow to violet, then to green, and finally dirty yellow brow. Sulphuric acid added as above causes the same reactions, but the process must be carefully conducted. The cherry-red and its disappearance are very strongly characteristic of this alkaloid. The reaction is most successful when the substance is dissolved in *cold* sulphuric acid and warmed, but not until the solanine becomes brown, as in that case the color reactions do not take place.

Another method of examination adopted by the author is to rub small portions of certain alkaloids with concentrated sulphuric acid on a white porcelain slab; to the mixture he then adds a few crystals of sodium nitrite. Certain changes of color occur, which again alter when alcoholic or aqueous potash solution employed in the previous experiments is added in drops, with constant stirring, until in excess; previous warming with the sulphuric acid is not desirable, unless when specially directed.

Atropine with sodium nitrite shows a deep yellow to orange. Alcoholic potash produces a splendid red-violet, quickly passing into pale rose; the more nitrite used, the deeper the color. Aqueous potash does not produce a color reaction.

Narceine with sodium nitrite first gives a dirty brown-green, then clear blue margin, the mixture gradually passes to a fine violet, red-violet, and a blood red. Alcoholic potash changes this to a yellow, but aqueous potash causes the violet to pass through yellow to a dirty brown. When the blue margin appears as above, if the mixture is very gently warmed, it becomes a magnificent blue-violet.

Narcotine with sodium nitrite passes gradually through red, brown, and green into a cherry-red. Alcoholic potash added changes this to a dirty orange; *aqueous* potash, when dropped into the mixture after the sodium nitrite, shows a green spot after each drop. When it has been added in excess, all becomes a dirty green; when narcotine is warmed with sulphuric acid until yellow, or till the characteristic violet appears and sodium nitrite is then added, a fine cherry-red immediately makes its appearance.

Strychnine with sodium nitrite gives a dirty yellow. Alcoholic potash changes it to a fine orange-red, the aqueous solution causes it to turn brownish-green, and finally dirty red-brown.

Digitaline with sodium nitrite gives a brown to dirty cherry-red color, changed by alcoholic potash to a dirty yellow gray, by aqueous potash to brown; the reaction with the sulphuric acid and sodium nitrite is peculiar to this alkaloid.

Two or three samples of each alkaloid were obtained from different sources. The processes followed in the experiments require a considerable amount of practice, and it is sometimes difficult to exactly specify the shade of color, for example, whether one should be called brownish-green or greenish-brown; yet with practice the characteristic reactions can be very accurately produced.

* *Arch. Pharm., Journal of the Chemical Society.*

CHEMICAL COMPOSITION OF SOME FOOD ANIMALS.*

By Sir JOHN BENNET LAWES, Bart., LL.D., F.R.S., F.C.S., and JOSEPH HENRY GILBERT, Ph.D., LL.D., F.R.S., V.P.C.S.

IN a former paper (*Phil. Trans.*, part ii., 1859) the authors had given the actual weights and the percentage proportion in the entire body, of the individual organs and of certain more arbitrarily separated parts of 326 animals—oxen, sheep, and pigs—in different conditions as to age, maturity, fatness, etc. They called particular attention to the wide difference in the proportion by weight of the stomachs and intestines in the three descriptions of animal; the proportion of stomach and contents being very much the highest in oxen, considerably less in sheep, and little more than one-tenth as much in pigs as in oxen. On the other hand, the intestines and contents contributed a less proportion to the weight of the body in oxen than in either sheep or pigs, the percentage by weight in pigs being nearly twice as high as in sheep, and more than twice as high as in oxen. With these very characteristic differences in the proportion of the receptacles and first laboratories of the food, the other internal organs collectively, as also the blood, contributed a pretty equal proportion by weight of the entire body, in the three descriptions of animal.

Ten animals had been selected for the determination of the chemical composition, namely, a fat calf, a half fat ox, and a fat ox; a fat lamb, a store sheep, a half fat sheep, a fat sheep, and a very fat sheep; a store pig, and a fat pig. In these in the collective carcass parts, in the collective offal parts, and in the entire bodies, the total nitrogenous substance, the total fat, the total mineral matter, the total dry substance, and the water, were determined; and the results were recorded and discussed in detail.

It was shown that as the animal fattened the percentage of nitrogenous substance decreased considerably, while that of the fat and of the total dry matter increased in a much greater degree. It was estimated that the portions of well fattened animals which would be consumed as human food would contain between three and four times as much fat as dry nitrogenous substance; and comparing such animal food with wheat flour bread, it was concluded that taking into consideration the much higher capacity for oxidation of a given weight of fat than of starch, such animal food contributed a much higher proportion of non-nitrogenous substance, reckoned as starch, to one of nitrogenous substance than bread. In fact, the introduction of our stable animal foods, to supplement our otherwise mainly farinaceous diet, did not increase, but reduce, the relation of the flesh-forming material to the respiratory and fat-forming capacity of the food.

Finally, the actual amount, and the percentage of total ash, in most of the internal organs, and some other separated parts, were given. It was shown that the percentage of total mineral matter, like that of the nitrogenous substance, decreased, not only in the entire body, but especially in the collective carcass parts, as the animals matured. It was the object of the present communication to record the results of the complete analysis of the ashes of the collective carcass parts, of the collective offal parts, and of all parts of each of the ten animals. Forty complete ash analyses have been made.

As was to be expected, more than four fifths of the ashes consisted of phosphoric acid, lime, and magnesia; these making up the largest amount in the ash of the oxen, less in that of sheep, and less still in that of pigs. Potash and soda were also prominent constituents. Assuming, for the purposes of the illustration, that one of phosphoric acid was combined with three of fixed base, the ashes of the ruminants showed an excess of base; whereas, according to the same mode of calculation, the ashes of the pigs showed no such excess.

It was, unfortunately, only in the case of the pigs that the ash of the chiefly bony, and that of the chiefly soft offal, parts had been analyzed separately. The results showed a considerable excess of acid, especially phosphoric, in the ash of the non-bony portions, presumably, in part at any rate, due to the oxidation of phosphorus in the incineration.

Comparing the percentage composition of the ashes of the entire bodies of the different animals, the chief points of distinction are that, in the ash of the pig there is a lower percentage of lime, and a higher percentage of potash and soda, than in the corresponding ash of the ruminants; a somewhat higher percentage of phosphoric acid in the ash of the pigs and of the oxen than in that of the sheep; and a higher percentage of sulphuric acid (and somewhat of chlorine also) in the ash of the pigs than in that of the other animals.

A table showing the quantities of total ash, and of each individual mineral constituent, in each of the ten animals analyzed was given. Not much stress was laid on the amounts in the particular animals, as the actual weights and conditions of animals coming under similar designations may vary considerably.

It was of more interest to consider the amounts of the mineral constituents in carcass parts, in offal parts, and in all parts, of 1,000 lb. fasted live weight of each description of animal.

It was shown that a given live weight of oxen carried off much more mineral matter than the same weight of sheep, and a given weight of sheep much more than the same weight of pigs. With each description of animal the amounts of phosphoric acid, lime, and magnesia are less in a given live weight of the fatter than of the comparable leaner individuals. Of both potash and soda, again, the quantity is less in a given live weight of the fatter animals. The same may be said of the sulphuric acid and the chlorine; in fact, in a greater or less degree of every one of the mineral constituents.

It was estimated that the loss to the farm of mineral constituents by the production and sale of mere fattening increase was very small. It was greater of course in the case of growing than of only fattening animals. In illustration, the amount of some of the most important mineral constituents removed annually from an acre of fair average pasture and arable land in various products may be compared. Such estimates can obviously be only approximate, and the quantities will vary considerably. With this reservation, it may be stated that, of phosphoric acid, an acre would lose more in milk, and four or five times as much in wheat or barley grain, or in hay, as in the fattening increase of oxen or sheep. Of lime, the land would lose about twice as much in the animal increase as in milk, or in wheat or barley grain, but perhaps not more than one-tenth as much as in hay. Of potash, again, an acre would yield only a fraction of a pound in animal increase, six or eight times as much in milk, twenty or thirty times as much in wheat or barley grain, and more than 100 times as much in hay.

From the point of view of the physiologist, it would doubtless have been desirable that the selection of parts for the preparation and analysis of the ash should have been different and more detailed. The agricultural aspects of the subject had, however, necessarily influenced the course of the inquiry, and the extent of the essential work had enforced the limitation which had been adopted. The results must be accepted as a substantial contribution to the chemical statistics of the feeding of the animals of the farm for human food.

* Abstract of a paper read before the Royal Society June 21, 1883.

READY TEST FOR SULPHITE OF SODA.

PHOTOGRAPHERS who use sulphite of soda, and who wish to know of its freedom from sulphate or otherwise, will find the following ready test useful and conclusive: From an oil shop or chemist's get one pennyworth of spirits of salts (hydrochloric acid) and dilute it with two parts of water. Also, procure a little *chloride* of barium and make a ten per cent. solution of it in water. In a wine glass put first about twenty drops of a saturated solution of the sulphite; to this add about one teaspoonful of the diluted acid, and then drop in a few drops of the barium solution. If the sulphite be perfectly free from sulphate, the liquid in the glass will remain clear; but if sulphate be present, the liquid becomes more or less milky according to the amount of sulphate present.

Sulphite of soda *perfectly* free from sulphate is very difficult to obtain or preserve, but a good sample should not show more than traces enough to make the liquid opalescent.

The following is the *rationale* of the above reaction: If a soluble barium salt be added to a solution of sulphite or sulphate, it is precipitated as sulphite or sulphate of barium. But sulphite of barium is soluble in dilute hydrochloric acid, while sulphate is insoluble; hence in the above reaction the sulphite of barium formed is kept in solution by the acid, while the insoluble sulphate is at once precipitated as a white powder, and gives a milkiness to the liquid.

When the hydrochloric acid is added to the solution of sulphite of soda, a powerful smell of burning sulphur is evolved. This is free sulphurous acid liberated by the hydrochloric acid decomposing the sulphite formation of chloride of sodium (common salt); but it in no way interferes with the action or delicacy of the test, as the hydrochloric acid does not attack the sulphate that may be present.

If great delicacy be required, it will be necessary to add some solution of barium to the dilute acid (especially if the common kind be used), as that sometimes contains traces of sulphates. It is also necessary that the *chloride* of barium should be used and not the *nitrate*, as the latter would at once oxidize a portion of the sulphite into sulphate. The above quantities will suffice for many dozen testings.—*Geo. H. Seward, A.P.S., in Br. Jour. of Photo.*

COMMON DEFECTS IN THE SANITARY ARRANGEMENTS OF HOUSES, AND THEIR REMEDIES.

RECENTLY at the Parkes Museum of Hygiene, Margaret Street, London, Prof. W. H. Corfield, M.A., M.D., gave an address on the above subject. Dr. Corfield remarked that the best point from which to begin the examination of the sanitary condition of a house was the top, and he would therefore, in pointing out the different mistakes and neglects likely to occur in a dwelling, deal first with those of the roof. The rainwater which fell upon its surface must be got rid of. That which fell on the sloping face next the front should be taken from the gutter in a pipe direct to the street; but in order to avoid the appearance of the pipe, the water was often conducted across the roof in a gutter, which might some day leak into a ceiling, or was even carried down inside the house walls, through one or two stories of bedrooms and the drawing-room, and so through the kitchen and basement to the drain. This pipe might at some time become broken, or was not carefully jointed, and then the rooms were flooded, and also in many cases were directly connected with the drain. Apart from this, the decay of leaves, soot, and dust collecting in the top of the pipe was a more frequent source of evil than was generally supposed. Such an arrangement often gave rise to bad smells in the house, and various amateur tinkerings were made to correct the evil, but the pipes themselves were often overlooked for years.

The lecturer had known several cases of illness which could only be attributed to this arrangement of rainwater pipes. Although open at both ends, such rainwater pipes often had an offensive smell, and yet these were frequently carried through bedrooms, and even as open channels under shelves. He believed more cases of illness than were suspected were due to this apparently insignificant cause.

Another common plan was to carry the rainwater pipes from the front to the back of the house through the ceilings of upper rooms. These pipes should always be kept outside the house, and should be disconnected from the drains; if directly connected, they were a source of danger, and even if separated by a water trap, disease might arise by their use. No spout heads should be placed below bedroom windows, although this was frequent, especially where the windows opened on to a parapet; such a plan ventilated the house drains at the expense of the occupants of the bedrooms. Foul air from the drain passed gradually through the trap, and the air in all such pipes might be assumed to be continually foul; and as soon as it rained, the air was driven out of the pipes and could only pass with ease upward. While on the roof, the ventilating pipes from the drain might be observed. These should be carried to such a level that wind freely passed over them. To couple them to the chimney, ending a little below it, not only prevented them from acting properly, but entailed a risk that the foul air might pass by a down draught into the various rooms.

Passing down into the house, the attention would first be called to the cistern or cisterns. These were of lead, or galvanized iron, and though unaffected by the waters supplied in the metropolis, both were attacked by certain impurities in water, and care should be taken to avoid the use of the metal likely to be affected by the water supply. In any case the cistern was provided with an overflow pipe, starting from a hole near the top, or a waste pipe rising from the interior of the cistern itself; the most natural course would seem to be that such a pipe should discharge on to the adjacent roof or its gutter, but till recently it was common to take the waste direct into the nearest pipe—it might be the rain water or the soil pipe as seemed most convenient to the plumber, and in the latter case it would be obvious that the foulest pipe in the house, and frequently the street sewer, was carefully ventilated into the household supply of drinking water.

The foul air in sewers and drains contained objectionable suspended matters, including, at times, the virus of typhoid fever, and these were absorbed by and contaminated the water. The main cause of the spread of typhoid fever in London and other large towns was this practice of connecting the drinking water cistern with the drain. A palliative often adopted was to put a trap to the pipe; but the true remedy was to make all overflow or waste to discharge into the open air. It was sometimes made to discharge into some pipe, with a common waste for that and the kitchen waste, and this was entirely wrong, as the water was foul, and the air passing through the pipe must also be foul. As a rule, again, the same cistern was used both for the supply of taps and waterclosets. It might be said that the taps supplied from the cistern were not those used for drawing off drinking water; but it might be presumed that any cold-water tap in a house was liable to be used at times as a source of drinking water. The plan of supply from one cistern might or might not be dangerous, according to the apparatus used for the closet supply. Where a spindle valve and ball lever were affixed it was bad, as at each discharge foul water from the pan of closet was liable to be jerked into the cistern. Another valve plan which was becoming usual was less dangerous, but still made too direct a communication between closet and drinking supply to be desirable.

The housemaid's sink was too often placed in a closet under the stairs, without either light or ventilation, and from the nature of the articles stored in this cupboard no very savory odor was exhaled when the door was opened. Then the material of the sink—wood lined with lead—was bad, as grease adhered to the surface. It should be of glazed stoneware, and be placed in a well lighted position. The waste pipe of this housemaid's sink was generally connected with the trap of the nearest closet; this was bad enough, but it was worse that it should communicate with the actual soil-pipe, as in other cases was done. When this was the case, a bell trap was placed on the sink; this was very inefficient at the best of times, was useless when dry, and was very liable to be displaced and then lost or broken. The bell trap was not self-cleansing, and was always foul. He might be asked what could be done with the waste of housemaid's sink, since the usual plans were so unhesitatingly condemned, and he would advise that it be carried through the nearest external wall, and discharged into the open air. More frequently than not the housemaid's sink was supplied with water from a cistern inside or over a w. c., such a supply sometimes furnished to other taps, was bad, for as the air of the cistern was that of the closet, it was sure to be contaminated, no matter how ingenious the valve arrangements might be. Sometimes the feed cistern for the hot-water apparatus was in this objectionable position, and its overflow passed into the closet.

Proceeding next to examine the closet itself at the top of the house, they would find that in the great majority of cases the apparatus was what was known as a pan, which was badly devised in almost every particular. The container was of iron, a material liable to rust when alternately wet or dry, and it formed practically a large iron box beneath the closet liable to be splashed with excretory matter, and so was full of offensive gases which passed into the closet, especially when the plug was pulled. The trap beneath was usually the D-trap, which never could be cleared, and which assisted in maintaining the general foulness of the apparatus. In many containers there was a hole bored through the top, an ingenious device for ventilating it and its evil-smelling trap into the house. Underneath it was a "safe tray" falsely so called—a shallow pan directly connected with the soilpipe, and a greater nuisance than the evil it professed to remedy. By a misplaced ingenuity this had a little D-trap itself, and lest it should run dry, the trap was fed by a little pipe from the cistern, thus polluting the drinking supply most effectually. The whole contrivance of a safe should be abolished. The pan closet was at once the worst form devised, and that most largely in use.

The lecturer showed a specimen with a stoneware container, but said he could not recommend it, although not so bad as the iron one; the principle was bad, and such a form of closet was not worth the trouble bestowed on attempts to improve it. The D-trap ought to be replaced by the siphon trap—another misnomer, for it ought not to siphon out. The extraordinary fact was that the pan closet and the D-trap were modern "improvements," and replaced, some 40 years since, the much more safe Bramah closet and simple bend or siphon trap. The closet should never be in the middle of a house, but always next an external wall, and if possible, in an annex. Lead pipes were slowly but surely perforated by foul air, and examples might be seen in the Museum perfectly riddled in this manner. The soilpipe into which the closet discharged, by some perversity, was usually carried inside the house, even where the w. c. itself was next an external wall. If of lead, the joints ought to be well "wiped;" and if of iron, melted metal should be run into sockets, instead of the red lead or putty favored by the workman. A greater danger of lead pipes inside a house was that they were liable to have nails driven into them. The lecturer was called into a house in which sickness had occurred, and was told that an unaccountable smell was sometimes noticed in the larder, although not near any drain. He noticed a nail in an angle, and on pulling it out found it quite loose, and with filth sticking to it; it had been driven into the soilpipe. An iron soilpipe should on no account be allowed to pass inside the house, as its joints were very unlikely to have been made airtight. No sacrifice of appearance or expense was too great to justify the non-removal of a closet from the center to the exterior of the house.

As an instance of what had been done in the way of carelessness, the lecturer described a D-trap he had taken up in a country house. It was made of zinc, with a safe tray of zinc, and three waste pipes—two of zinc and one of lead; these passed into an iron pipe, and that ended in an unventilated cesspool. The apparatus was corroded full of holes and was placed in a central closet having no window. The occupants of the house had expressed astonishment at the abominable smells which pervaded the house. It might be asked how could he account for typhoid fever, which he had said was often found in proximity to such places, never having broken out in this house? It had not occurred there because the specific contagion had not been introduced; unless this was imported into a place, no town, however favorable the insanitary conditions might be, suffered from typhoid fever. In the bath-room the same pipe should not be used for inlet and outlet, for in that case the scum of the last and dirtiest water discharged was the first to be brought back again. The waste pipe and that from the safe tray should be taken outside and discharged into open air. The waterclosets below might be dismissed with a reference to what had already been said, except that these were less likely to be well looked after, and had less ventilation. An excessively bad plan on the best bedroom floor was to have a watercloset opening out of or actually placed in the chief bedroom.

In the balcony or conservatory opening off the drawing-room the rainwater pipes needed attention; the rooms were often only protected from these and other pipe openings by the flimsiest guards. Not unfrequently there was in the drawing or dining-room an unaccountable smell noticed by those sitting in a particular chair close to the fire when it was alight. It often proceeded from the opening for the bell wire, and was caused by the fact that close to the bell in the basement passage a gaslight was burning, and the heated products found their way upward in the holes made for the bell wire, aided by the draught of the fire on the upper floor. In the basement, small holes would often be found in the floor to allow of the escape of the water used in washing down the floor. These openings communicated directly with the house drain by means of a bell trap, which he had already shown to be useless, or worse, and the sinks were too often connected with the drain by similar traps. He might, however, remind his audience that these, and all traps, were most dangerous when the closet or sink was not in use, as then the water evaporated, and thus they were simply open holes by which the drain and sewer were ventilated.

The lecturer explained the practice of disconnection, urging that all traps should be of the siphon form, discharged under grids in the open air outside the dwelling. The waterclosets in basement were too generally supplied from the drinking water cistern; they should always be supplied with water waste preventers discharging a copious supply of water, two gallons, by instant action, when a chain was pulled. The rainwater pipes ought to discharge on the surface, and there should be siphon gulleys with open stoneware bends. No watercloset should be permitted to remain in a scullery or kitchen; but if they existed they should at once be removed.

The dipstone trap often seen inside kitchen floors was an ingenious contrivance to keep back foul substances and let the clearer liquid stream off from the top. Stoneware was the best material for a house drain, and the joints should be made good with cement, care being taken to see that no pipes were laid with the socket the wrong way, or the material would be washed out. The interior should be clear from cement, or the pipe would be gradually blocked up. In order to test the drains, before taking a house, the lower end of drain should be plugged up and the drain filled with water; if it remained full for a while, the joints might be pronounced sound. A manhole for access should be provided at the outlet of drain into sewer, and this should be protected by an open grating, while the soilpipe should pass, of full diameter, to the top of the house for ventilation. Persons were often much afraid of a grating over manhole; but repeated experiments with a lighted lamp would show that the deflection of flame, and therefore the current, was always toward the opening, except at the moment a closet was being discharged, and then the air that came down was the last that had been drawn into pipe. If the action was reversed, the householder might depend upon it there was some obstruction in the pipes which needed seeing to.

LOCUSTS AS FOOD FOR MAN.

By DAVID ALEXANDER LYLE, U. S. A.

THIS subject may appear to some, if not all of you, a rather peculiar one. The eating of insect flesh is entirely repugnant to our feelings and at once arouses all our natural and inherited antipathies. Even those who accept literally the Mosaic history of the creation as set forth in the book of Genesis, are loth to take advantage of the permissory bill of fare granted by Divine authority in the book of Leviticus. In the eleventh chapter of Leviticus, verses 1, 21, and 22, will be found these words:

1. "And the Lord spake unto Moses and to Aaron, saying unto them: . . .

21. "Yet these may ye eat, of every flying creeping thing that goeth upon all four, which have legs above their feet, to leap withal upon the earth;

22. "Even these of them ye may eat; the locust after his kind, and the bald locust after his kind, and the beetle after his kind, and the grasshopper after his kind."

Other references may be found in the Bible to the use of locusts as food. In one place in particular, in Mark i., 6, we read that "John was clothed with camel's hair, and with a girdle of a skin about his loins; and he did eat locusts and wild honey."

From these passages we learn that in olden times locusts were considered to be an article of food, and wild honey, which is an insect product, is highly prized by both aboriginal and civilized communities even to this day. In no one particular are we so much the creatures of custom and habits as in eating. That which is a delicacy to one is disgusting to another. The food relished by one nation or tribe may be spurned by another as loathsome. The inhabitants of the interior and mountains are often nauseated by the toothsome dishes of the denizens of the coast. A knowledge of the habits of certain animals (I use the term "animals" in its biological sense as distinguished from plants) often give rise to an unconquerable abhorrence of the use of their flesh as food. To show how empirical are man's standards of edibles, it will only be necessary to cite a few instances. Beef, for example, is an almost universal article of food. But, should I place before my readers a roast of beef and tell them that this meat was taken from an animal that was accidentally drowned yesterday, my guests would very likely be indignant as well as disgusted, while at the same sitting they would eat and praise the flavor of a fish caught upon the same date and then left to *drown* in the air, if I may use the term, while it flops about and writhes with all the intensity of agony of which its low nervous organization is capable. We dote upon lobsters and lobster-salad, while a shudder of horrible disgust runs through our frames at the idea of eating a buzzard or a hyena. Yet the lobster is the scavenger of the sea as truly as the others perform the same functions upon the land.

We love the speckled beauties that haunt the mountain streams, feeding upon insects and worms, while the Apache Mojave Indians turn in scorn from such a dish. The same Indians will regale themselves with the blood that flows from the death wound they have just inflicted upon a deer, and will eat with relish the liver, smaller intestines, etc., while yet warm, and with little or no preparation; but we could hardly be induced to imitate their example.

Nothing can be more omnivorous and filthy in their feeding habits than chickens and swine: yet we relish the flesh of both with zest. Tripe, liver, and kidneys are esteemed by us, though a knowledge of their functions might cause a tremor of squeamishness to thrill through our bodies. As epicures we eat the diseased livers of geese, insect-eating frogs, small birds, and game in an advanced stage of decomposition, and call them delicious as we discourse upon their "gamy" flavor, and at the same time we would not entertain for a moment the idea of eating a dish of freshly-roasted locusts which have fed upon the clean, juicy herbage of our fields. The Hebrews of North Africa eat boiled and fried locusts with avidity, while their coreligionists in this country turn from lobsters with scornful loathing.

The Arab relishes the savory dishes made from locusts, while he expresses his abhorrence of our habit of eating raw oysters. Our society belles shriek with horror and fright at the appearance of a cockroach, yet they sip with pleasure the sherry and madeira wines that are aged, mellowed, and flavored with these pests.

Professor Charles V. Riley, for a long time State Entomologist of Missouri, and now Entomologist at the United States Agricultural Department at Washington, undertook in 1875 a series of experiments "to demonstrate the availability of locusts as food for man, and their value as such whenever, as not infrequently happens, they deprive him of all other sources of nourishment." Professor Riley took a lot of locusts to a hotel to be cooked, but he endeavored in vain to obtain assistance from the monarchs of the gridiron. The cooks and servants retired in disgust, and left the naturalists to do their own cooking. The savory messes that the latter concocted converted the kitchen; cooks and guests alike agreeing that the soups, fricassees, and fritters, composed materially of locusts, were excellent. In regard to these experiments Professor Riley says:

"It had long been a desire with me to test the value of this species (*spretus*) as food, and I did not lose the opportunity to gratify that desire which the recent locust invasions into some of the Mississippi Valley States afforded. I knew well enough that the attempt would provoke to ridicule and mirth, or even disgust, the vast majority of our people, unaccustomed to anything of the sort, and associating with the word 'insect' or 'bug' everything horrid and repulsive. Yet I was governed by weightier reasons than mere curiosity; for many a family in Kansas and Nebraska was, in 1874, brought to the brink of the grave by sheer lack of food, while the St. Louis papers reported cases of actual death from starvation in some sections of Missouri, where the insects abounded and ate up every green thing in the spring of 1875.

"Whenever the occasion presented, I partook of locusts prepared in different ways, and one day I ate of no other kind of food, and must have consumed, in one way or another, the substance of several thousand half-grown locusts. Commencing the experiments with some misgivings, and fully expecting to have to overcome disagreeable flavor, I was soon agreeably surprised to find that the insects were quite palatable in whatever way prepared. The flavor of the raw locust is most strong and disagreeable, but that of the cooked insect is agreeable and sufficiently mild to be easily neutralized by anything with which they may be mixed, and to admit of easy disguise, according to taste or fancy. But the great point I would make in their favor is that they need no elaborate preparation or seasoning, and that they really require no disguise; and herein lies their value in exceptional emergencies, for, when people are driven to the point of starvation by these ravenous pests, it

follows that all other food is scarce or unattainable. A broth, made by boiling the unfledged *caloptenî* for two hours in the proper quantity of water, and seasoned with nothing but pepper and salt, is quite palatable and scarcely to be distinguished from beef-broth, though it has a slight flavor peculiar to it and not easy to be described. The addition of a little butter improves it, and the flavor can, of course, be modified with mint, sage, and other spices *ad libitum*. Fried or roasted in nothing but their own oil, with the addition of a little salt, they are by no means unpleasant eating, and have quite a nutty flavor. In fact, it is a flavor, like most peculiar and not unpleasant flavors, that one can soon learn to get fond of. Prepared in this manner, ground and compressed, they would doubtless keep for a long time. Yet their consumption in large quantities in this form would not, I think, prove as wholesome as when made into a soup or broth, for I found the chitinous covering and corneous parts, especially the spines on the tibiæ, dry and chippy, and somewhat irritating to the throat. This objection would not apply with the same force to the mature individuals, especially of the larger species, where the heads, legs, and wings are carefully separated before cooking; and, in fact, some of the mature insects prepared in this way, then boiled, and afterward stewed with a few vegetables, and a little butter, pepper, salt, and vinegar, made a good fricassee. . .

"I sent a bushel of scalded insects to Mr. John Bonnet, one of the oldest and best-known caterers of St. Louis. Master of the mysteries of the *cuisine*, he made a soup which was really delicious, and was so pronounced by dozens of prominent St. Louisians who tried it. Shaw, in his 'Travels in Barbary' (Oxford, England, 1738), in which two pages are devoted to a description of the ravages of locusts, mentions that they are sprinkled with salt and fried, when they taste like crawfish; and Mr. Bonnet declared that this locust soup reminded him of nothing so much as crawfish *bisque*, which is so highly esteemed by connoisseurs. He also declared that he would gladly have it on his bill of fare every day if he could only get the insects.

"His method of preparation was to boil on a brisk fire, having previously seasoned them with salt, pepper, and grated nutmeg, the whole being occasionally stirred. When cooked, they are pounded in a mortar with bread fried brown, or *purée* of rice. They are then replaced in the saucepan and thickened to a broth by placing on the warm part of the stove, but not allowed to boil. For use, the broth is passed through a strainer and a few *croutons* are added. I carried a small box of fried ones to Europe, where they were tasted by numerous persons, including members of the London Entomological Society and of the Societe Entomologique de France. Without exception, they were pronounced far better than was expected, and those fried in their own oil, with a little salt, remained good and fresh for several months; others fried in butter became slightly rancid, a fault of the butter. Mr. C. Horne, F.Z.S., writing to *Science Gossip*, says: 'In the evening I had asked two gentlemen to dinner, and gave them a curry and croquette of locusts. They passed for Cabool shrimps, which in flavor they very much resembled; but the cook having inadvertently left a hind leg in a croquette, they were out, to the infinite disgust of one of the party and the amusement of the other.' . . .

"Locusts will hardly come into general use for food, except where they are annually abundant; and our Western farmers, who occasionally suffer from them, will not easily be brought to a due appreciation of them for this purpose. Prejudiced against them, fighting to overcome them, killing them in large quantities, until the stench from their decomposing bodies became at times most offensive, they find little that is attractive in the pests.

"For these reasons, as long as other food is attainable, the locust will be apt to be rejected by most persons. Yet the fact remains that they do make very good food. When freshly caught in large quantities, the mangled mass presents a not very appetizing appearance, and emits a strong and not overpleasant odor; but rinsed and scalded, they turn a brownish red, look much more inviting, and give no disagreeable smell."

That locusts have been used as a food from remote antiquity is well attested by historical writers. As stated before, they are classed among the "clean meats" in Leviticus (xi. 22), and are referred to in other parts of the Bible as human food. One of the Nineveh sculptures deposited in the British Museum represents men carrying different kinds of meat to some festival, and among them some carrying long sticks, to which locusts are tied, thus showing that they were of sufficient importance to form part of a public feast.

Locusts have been, and are yet, extensively employed as an article of food in parts of Europe, Asia, and Africa. The Romans are said to have roasted them to a bright golden yellow before eating them; and in Russia they are salted or smoked like herrings. Pliny says that locusts were highly esteemed by the Parthians; Herodotus speaks of a tribe of Ethiopians that fed on locusts; and the records of their use in ancient times as food, in both Southern Europe and Asia, are abundant. At the present day this use still continues.

Riley, in his narrative,* says: "Locusts are esteemed very good food by the Moors, Arabs, and Jews, in Barbary, who catch large numbers of them in their season, and throw them, while jumping alive, into a pan of boiling *argan* oil; here they hiss and fry until their wings are burned off, and their bodies are sufficiently cooked, when they are poured out and eaten. I have seen many thousands cooked in this manner, and have had the curiosity to taste them; they resemble, in consistence and flavor, the yolks of hard boiled eggs."

The Riff Arabs, when they see a swarm of locusts hovering in the air and clouding the sky, watch them with anxiety, and when they descend near their habitations they receive them with shouts of gratitude to God and Mohammed, throw themselves on the ground, and collect them as fast as possible. The locusts, deprived of their heads, legs, and wings, are well boiled in butter, and served up with a substance called *aleuzcus*. The Riff Arabs consider them delicious food. Their camels also eat them greedily. The Moors use them to this day, by first boiling and then frying them. The Moorish Jews, more provident than their Mussulman neighbors, salt them and keep them for making a dish called *dafina* which forms the Saturday's dinner of the Jewish inhabitants. This dish is made by putting meat, fish, eggs, tomatoes, locusts, "in fact, almost anything edible, into a jar, placing the latter in an oven on Friday night, and then taking it out hot on the Sabbath." In this manner the orthodox Hebrew gets a hot dinner without committing the sin of lighting a fire upon that day.

The Indians of California and the Great Basin also collect locusts for food. The Digger Indians roast them and grind or pound them into a sort of flour, which they mix with pounded acorns, the nuts of the pinon pine, or with berries. This mixture they make into cakes and dry in the sun for future use.

Among the other uses to which locusts are applied is fish bait for the sardine fisheries off the coast of Spain; and similar bait might be prepared by the Western farmers for use upon the Atlantic and Pacific fishing grounds. A very important chemical substance used in the arts may be extracted from locusts by the action of sulphuric acid. This is formic acid, for which many applications have been found in therapeutics and in the laboratory. By collecting, killing, and burying them in trenches, or in compost-heaps, these insects might be utilized as fertilizing agents, or they might be collected in large quantities, dried, and sent East in bales as food for poultry.

Although the writer does not profess to be an advocate of entomophagy, nor does he intend to become an acridophagist himself, unless absolutely necessary, yet he believes, with Professor Riley, that, when the devastations of the Rocky Mountain locusts lay waste our Western domain, the inhabitants of these regions need not die for want of food so long as a supply of locusts exists. Persons should not allow prejudice and squeamishness to stand in the way of self-preservation.—*Popular Science Monthly.*

* Published in 1859.

THE ORIGIN OF ATMOSPHERIC ELECTRICITY, AND ITS CONNECTION WITH THE ELECTRICAL OCCURRENCES UPON OUR GLOBE.

By L. ZEHNDER, Basle, in *Dingler's Polytechn. Journal.*

FRICTION always generates electricity; this is a fundamental law, and I maintain that not alone the so-called frictional electricity, but also galvanism produced by chemical processes, thermo-electricity, electricity from steam issuing from a steam boiler, etc., owe their origin to the friction of the smallest atoms.

I shall base the following remarks upon the electricity developed by an insulated steam boiler. The generation of electricity is undoubtedly due to the intense friction of the steam upon the sides of the aperture, from whence it issues with a velocity of several hundred meters per second; leaving external shape out of view, a great similarity will be found to exist between such a steam-electricity machine and an ordinary one with glass disk. I next assert that electricity would also be obtained from such a boiler, only less in quantity, if in place of pure steam a mixture of air and steam, or even a very moist air, were caused to violently issue therefrom, and that every mouthpiece of the escape aperture will contribute to the development of the electricity; the quantity only of the latter will vary, in accordance with the nature of the mouthpiece; this may consist of wood, moist conducting stone, or other material. I next suppose, in place of the stationary electricity conductor (the boiler) and the impelled moist air, a movable conductor and stationary moist air. Let a body, consisting of some conducting material, be very rapidly moved in moist air; electricity will be developed at the places of contact of these two bodies, and principally at the places exposed to greatest friction. Let such a body be a globe revolving with great velocity around its axis, and the electricity will chiefly be generated at its equator. If the globe is a good conductor, then the electricity collecting within will seek to escape to the poles, being repelled from the faces of excitement by the freshly generated similar electricity. As for the vapor-saturated air itself, which became electric by friction with the globe, it is driven away from the equator by centrifugal force, and also seeks to attain the poles of the globe, in order to equalize the electricity.

The step is not so great to imagine in place of this globe our earth, which does not only revolve around its axis, but also relatively in the air enveloping it. The earth at the equator has a circumference velocity of over 400 meters per second. The air surrounding it also will in part make this revolution, but it is very apparent that as an elastic body it can never preserve equal rate with the earth, since it is ever restrained by the ether surrounding the atmosphere and filling space. It cannot be presumed that the entire stratum of air together with a part of ether is constantly whirled around with the earth. On the contrary, the greatest reduction of velocity of the air must take place near the earth's surface, where the circumference velocity is still less than that at a greater radius. But as soon as a difference of velocity between earth and air exists, friction between the two is produced, and, consequently, electricity.

The processes of the motion of air by a globe revolving in quiet air and by the earth, are, on the whole, exactly the same: The earth, in its revolution, whirls the surrounding air partially along; by the rotation of the air directly touching the surface of the earth, centrifugal force operates upon it, more especially at the equator, where it is driven away; it will for a time continue to revolve in the direction of the earth's revolution; but this motion is gradually lost, and in place it recedes farther and farther from the earth's surface. It is self-apparent that the air repelled from the equator must be replaced. But since the air over the entire surface of the earth has the tendency to withdraw therefrom, except at the poles, no other circular motion remains for it than from the equator toward the outer limit of the atmosphere, where, undoubtedly, only a small revolution of the air mass can take place; it there must make room for the constantly arriving quantities, and is forced to seek the poles of the atmospheric globe, where, unopposed, it approaches the earth. From the poles it passes, favored by the centrifugal power operating upon it, by the shortest possible and unopposed path over the earth, in order to constantly replace the air driven away from the equator. It cannot be supposed that the air generally will pass direct upon the earth's surface in its path from the poles to the equator, as the resistance offered by the many inequalities of the earth would be too great. It will generally be found that this fairly regular current, especially in mountainous countries, can be encountered only at a certain distance above the earth. The specific gravity exerting its influence upon the air is not able to counteract this motion, because by reason of the extraordinary elasticity of the air, its equilibrium, with regard to specific gravity, is never disturbed.

This view is supported by the observation of the winds occurring especially upon the open ocean, where the air meets with very little resistance, and where, consequently, the cold air, flowing from the poles to the equator, approaches the immediate terrestrial surface. The northeastern are the generally predominating winds upon the northern hemisphere, while the southeastern ones prevail upon the southern, most especially in the vicinity of the equator. If these directions of wind are divided in accordance with the meridian and latitude, two components will at first result in the direction of from east to west; consequently the entire atmosphere actually remains behind by the rotation of the terrestrial globe; secondly, two components from the poles toward the equator will result—a proof that the air leaves the earth's surface at the latter, and withdraws to the exterior strata of the atmosphere, since a constant and general air current toward the equator would be impossible without this. We have similar occurrences with the currents of the ocean; the water flows from east to west at the equator, and seeks to return by a path as far remote from the equator as possible, at the same time choosing a not unduly long route, and one offering but few obstacles. If the entire hot zone surrounding the earth were a continuous extent of water, no counter currents would be necessary, and the tendency of the water from east to west would be still more pronounced. (The path to be chosen by the counter current depends upon the shape of the continent embracing the water surface.) Similar analogies can be pointed out with the processes occurring in the interior of the earth—the earthquakes, the outpourings of lava in the hot and of water in the cold zones.

The heat of the sun is another factor for producing motion in the air. The sun heats the air, especially upon the terrestrial surface; the hot, lighter air mounts upward, and is replaced by the colder and heavier. By far the greatest difference, however, exists between the respective temperatures at the poles and at the equator, an additional reason to draw the air from the poles to the hot zone; and it is very palpable that the air current in the highest regions from the equator to the poles is absolutely necessary for establishing equilibrium. The co-operation of the centrifugal force and heat upon the motion of the air is very strikingly confirmed by the occurrence of the violent trade winds during the period of the equinoxes, because during these days those two causes operate together and exert their maximum influence at exactly the same place, while during the balance of the time they are capable to counteract and absorb each other almost entirely.

As was explained above, electricity is generated between the earth and moist air, when they rub upon each other. Friction is partly greatest at the equator, and partly is evaporation and the water percentage of the air greatest in the hot zone, in consequence of the intense heat, so that all the conditions for a strong development of electricity are there very eminently present. Most especially will this development take place with violence, if the sun heats the air over a great extent of terrestrial surface; this air is driven upward, and, for its replacement, fresh quantities will rush in over equally strongly-heated sea or ocean water. This air will arrive upon the land thoroughly saturated with aqueous vapors, and in consequence of the large frictional faces must generate very powerful quantities of electricity. The electrified aqueous vapor is repelled by the exciting surface, and only can withdraw from the earth, to seek the extremest strata of the atmosphere. The earth conducts the electricity developed by it over the shortest path to the point most remote from the exciting plane, consequently in the meridional direction toward the poles. Since the constant equalization of the developed unequal electricity is indispensably necessary, so is also the electrified aqueous vapor accumulating at the atmospheric equator (and also in consequence of the expulsion of the freshly arriving electricity) forced to seek the path to the poles of the earth, so that also these electric forces favor and accelerate a constant air current in the mentioned direction.

In tenor with the experiments with steam boilers as electricity generators, by which the steam is positive electric, the aqueous vapor, due to the friction of the water laden air with the earth, must also be *positive* electric, while the earth becomes *negative*. The positive electricity of the aqueous vapor, therefore, mounts upward with the vapor bubbles to the surface of the atmosphere, in consequence of the above stated reasons, and more and more loses its rotary motion imparted to it by the earth. From hence it divides and endeavors to reach the two poles. Now, if we imagine the earth as retained in place, and the slowly following air instead moved in an opposite direction, then the electric aqueous vapor revolves in the direction from east to west around the earth, and at the same time, at least after it has arrived in the upper strata, it has components toward the poles. If, now, the so-called atmospheric normal electricity is positive, and if electricity is incessantly generated at the equator or in the hot zone, then the presence of a large number of currents of positive electricity, from the equator to the poles, with strong components from east to west, must result therefrom.

It is known that a vast quantity of iron in a more or less pure condition is found in the earth. The electric currents, now, operate upon this iron, in such a manner that the different iron beds of the earth are all changed into electro-magnets, or, in other words, that the whole quantity is converted into one large electro-magnet. At a closer investigation, and supposing the center of the earth as point of observation, it will result that the components falling in the meridional direction of all electric currents flowing from the equator to the poles, always find an equally large contrary directed component in the meridian revolved by 180°, although in the same parallel circle. These equally large and contrary directed components neutralize each other in their influence upon the earth; only those directed from east to west remain effective, and unite, so that necessarily the north and south poles of the earth must at the same time be approximate poles of the terrestrial electro-magnet.

We have seen that the electricity of the aqueous vapor mounting upward at the equator is positive; the positive electricity revolves in a direction from east to west around the earth. By taking a position upon the north pole of the earth, we will observe that the electricity moves in the direction of a watch hand, *the magnetic pole in the north must be a south pole, and, vice versa, that of the south must be a north pole*, which agrees well with known facts.

If the earth were understood to be a permanent magnet, and not an electro-magnet, then the periodical variations of the magnetic needle, differing at every locality from the actual meridian, could no longer be explained. Both the north and south poles of the electro magnet, influenced by electric currents, are besides this mainly dependent upon the division of iron in the earth's crust. Let us imagine the total quantity of iron concentrated into one rod, traversing the earth, and about parallel with its axis, then the magnetic poles can be generated only at the ends of this rod; if the direction of the latter does not coincide exactly with the earth's axis, then the magnetic south and north poles cannot concur with the geographic poles. Nor can it be supposed that a single bed of iron in the earth's crust is equally divided all around; on the contrary, it is probable that these beds are of very varying shapes and dimensions, and unconnected, even in parts. An entirely isolated bed of

iron, for instance, will become magnetic under the influence of the atmospheric current of electricity; it will receive a north and a south pole, both of which induct opposite poles in the nearest beds, and thus after all contribute indirectly to the strength of the general magnetic pole. If, now, a magnetic needle is suspended in the proximity of such an isolated bed, then not alone the magnetic poles of the earth, but most certainly also the much closer ones of the bed of iron, will become effective, and these latter are capable of causing the deflection of the needle from the direction of the magnetic poles of the earth.

The daily oscillations of the magnetic needle are now easily comprehended. In accordance with whether a solid or a fluid surface of the earth is exposed to the vertical rays of the sun, the generated quantity of electricity either increases or decreases. It is hardly imaginable that an important amount of electricity can be produced by two more or less kindred substances. According to the above expressed views, for instance, the greatest quantity of electricity is developed in summer upon the African continent, taking place at about 12:30 o'clock of central European time, because Central Africa lies farther to the east. If we add to this about one-half hour, to allow for the rising of the electric vapor bubbles, and for the gradual remaining behind the revolution of the earth, therefore for the total gathering of force of the electric current, then the magnetic south pole, in consequence of the largely augmenting magnetism of the iron masses in Africa, must at about 1 o'clock of our time move a little to the east; this effects that the north pole of the magnetic needle must about this time also deflect to the east in Central Europe, which, according to my knowledge, fully coincides with known observations. A similar occurrence can be shown that the total quantity of electricity generated upon earth about attains to a maximum when the sun stands vertical, above Central America, because it also operates there upon a vast extent of surface, while at the same time a large quantity of electricity is furnished by Africa and South Asia at an early evening hour. Consequently, the total terrestrial magnetic force must be greatest at a later central European evening hour, by taking into account the difference of time of the meridians of the two continents under debate. For self-apparent reasons, these two examples can only serve as two very inexact comparisons, and we will retain this part of the subject for a future investigation, when we will go so far as to demonstrate by calculations a connection between the shape of the continents in the hot zone and the *daily* variations of the terrestrial magnetism.

The *annual* periodical variations may also be similarly explained by the ever varying effect of the sun, since this, in summer and winter, shines on totally different shaped and large surfaces of the earth. For instance, Africa, which may perhaps be considered as the greatest source of electricity by reason of its being the largest uninterrupted surface of the hot zone, produces large deviations of the needle in summer; in winter, however, when its portion of surface exposed to the hottest rays of the sun is far smaller, also the deviations of the needle are far smaller in Europe about that time of day.

Centennial changes are less easily explained. They are probably caused by interior violent revolutions, for instance, that during earthquakes, vast quantities of iron penetrate into fissures and cavities of the earth's crust. It is also possible that by strong earthquakes large bodies of iron are brought in proximity with the incandescent interior of the earth, and are thereby raised again to a temperature at which electric currents no longer can produce magnetism.

The mining of iron may perhaps exert no essential influence upon the position of the magnetic needle. Nevertheless, it is singular that the isogonal line without alteration showed a strong deflection to Europe about 250 years ago, while at present, the mining of iron having been vigorously pursued during that time, said line has withdrawn more and more. Of course, the iron is in general not lost to a certain locality, since it is seldom transported far; still, it is reduced into smaller and more compact masses, such as machinery, bridges, and the like, which parts of iron no longer form large electro-magnets in connecting layers, and are no longer capable of transporting magnetism northward with the same facility, being generally situated too far apart.

I am at a loss to know in what other manner terrestrial magnetism could reasonably be explained; it may perhaps be asserted that meteors prove that the iron in the universe must already be magnetic from other unexplained causes. It is known that the meteors enter our atmosphere with incredible velocity, in it heat to incandescence, and consequently lose their inherent magnetism. On the contrary, it is necessary that by the reduction of velocity and the subsequently occurring cooling the iron of the meteor, in consequence of the influence of the powerful electro-magnet of the earth, must assume a rather high degree of magnetism. Our entire globe could in a like manner obtain its permanent magnetism only through causes which operated after it had passed from a fluid and incandescent condition into one at least partially solid and at a lower temperature. The motion of the air, produced by centrifugal force, generates by friction a constant quantity of electricity, while that produced by the sun's heat is variable. Only hereby are explicable the trifling diurnal and annual deviations and the strong and regular magnetism of the earth.

During the equinoxes, when the sun stands vertically above the equator, the electricity will divide itself about evenly toward both poles. An important difference, however, exists between the two hemispheres, both in summer and winter. In summer, for instance, the hot zone between the northern tropic and the equator must be the principal electricity-generating plane. Moreover, in consequence of the heat, the air must arise especially from this plane, and transport the electrified vapor molecules upward. Now, since the electricity of the earth, of the same quality everywhere seeks to establish the greatest density at a point most remote from the exciting plane, in consequence of repulsion, the greater part of the terrestrial electricity gathers at the south pole at this season of the year. The current of the air will also tend with greater force toward the south pole, being much colder in summer time, so that by far the greater part of the developed electricity must now be equalized at this pole. Heat, together with the greater water percentage of the air, predominates in summer upon the northern hemisphere. The moderate zone contributes far less to the development of electricity than the hot, and is therefore barely able to act, as a generating plane, with a repellent effect upon the (positive) normal electricity; since, moreover, air, constantly charged with aqueous vapor, while containing but little electricity, can mount into the higher regions, air which, perhaps, when no intense friction has taken place, is charged with the electricity of the earth (therefore, negative), a means is offered to the normal electricity to equalize with the contrary electricity of the earth, before it has reached the north pole, either by descending from its highest position direct through the very moist air changed into a good conductor, down upon the earth, or that it only reaches at first an intermediate cloud, in order to afterward seek its way to the earth. In the vapory atmosphere of the moderate zone, the electricity, which flowed northward, will equalize both in rapid and slow discharges, and only a part of it actually reach the north pole.

Upon the southern hemisphere, the hot zone is also a powerful generator of electricity; its moderate zone, however, is cold, and consequently contains less aqueous vapor, whereby it becomes a bad conductor. The cold zone is a still worse conductor; although electricity has a special tendency to equalize at the south pole in summer, for above specified reasons, still, this can occur only by an incessant discharge at the latter, since the electrically discharged air descends at the pole, until electricity is able to pass over, partly in consequence of the natural motion of the air, and partly by reason of the attraction of the two different electricities. This to a certain extent slow discharge of an immense quantity of electricity produces the *southern* light, (*aurora australis*), as the *northern* light (*aurora borealis*) is produced by the same causes in winter at the north pole. That our northern atmosphere contains a vast quantity of electricity, especially in winter, is proven by many experiments and observations. According to these, the normal electricity attains its maximum tension in January, as does also the electricity of the fog arising from the earth; which fog has become charged with electricity by friction with the terrestrial surface.

If a cloud were completely devoid of electricity, then all its particles, be they either vapor bubbles or minutest water-globules, would very quickly unite into larger drops, by reason of their gravitation, and fall to the earth. The prolonged existence of a cloud can only be explained by its electric condition. I assume minute globules of water to be the smallest atoms in explaining the forces operating in the interior of the cloud. The operations are afterward easily applied to the recently supported hypothesis of vapor bubbles.

Every globule of water exerts an attractive force (gravitation) upon those lying nearest, whose points of application, by the extremely small distance intervening between the two bodies, lies still very nearly both to its center of gravity and center. But at the same time, the electricity of the globule, which collects upon the very outside of its envelope, acts as a repellent power, with point of application, by reason of the minute distances, far nearer to the surface of the globule than the point of application of the previously mentioned force of attraction. When we remember by the very small distances under consideration that the nearest hemispheres of two adjoining globules exert a by far greater influence upon each other, and that the electricity is only evenly distributed upon the surface of each hemisphere, while the water fills the interior, the above assertion is proven, because the center of gravity of the surface of a hemisphere lies always farther from the center of a sphere than the center of gravity of the full hemisphere. As soon, now, as the total electric repellent influence of each water globule upon the adjoining one is smaller than its attractive force upon the same, then a condition of equilibrium must be established, and a scattering of the cloud is not possible. If the repellent force of the electricity is very small, the globules approach up to contact, formation of drop begins, and precipitation follows. But if the electric repellent force acts more strongly than the attractive, the globules will separate farther and farther from each other. With very strong electric tension, they will even be divided into atoms so minute as to be no longer visible. The case is the same if instead of water globules we consider vapor bubbles. The effects are exactly alike, because the latter may be regarded as hollow spheres with definite thickness of wall, while the electricity is found, as it were, upon a hollow sphere, with infinitely thinner wall, enveloping the vapor bubble. The above explained difference of the points of application of the attractive and repellent powers must be somewhat smaller, but a difference continues to exist, and consequently also the effects. Only the presence of these electric forces admits of our understanding that smoke issuing from a chimney, and which rapidly cools in air, the smallest particles of which unite into larger bodies by contact with each other, and would have to drop back again, in reality scatters more and more in air, and at last becomes invisible. Again, the frequently peculiar shape of clouds, which they still retain even after a rapid change of locality, can only be explained by the presence of an absolute condition of equilibrium.

Taking as basis the above established facts, I will next treat of thunderstorms. For this purpose I suppose a very hot sultry summer's day in the moderate northern zone. The sun unobstructed by clouds thoroughly heats a large extent of territory; the heated air mounts upward, together with the vapor of the evaporated water, and makes the atmosphere a good conductor, thereby facilitating electric discharges from above down to the earth. By the produced violent motion of the air upward, the air resting upon the earth is compelled to follow, and the clouds surrounding the strongly-heated extent of surface will be driven over the place. Now, the produced conducting air column in the first instance promotes the slow passing over of the negative terrestrial electricity into these clouds driven into the column, and electrifies them negatively if they were not in this condition already. But by the gradual conversion of positive into negative electricity within the interior of the cloud, a neutral condition will set in at some time, during which rain is formed, which again assists in improving the conductivity of the air column, and accelerates the passing over of the terrestrial electricity into the cloud (the short, feeble fall of rain often preceding the violent sudden discharges).

When sufficient negative electricity has accumulated in the cloud, a discharge of positive normal electricity from the uppermost strata will occur toward it, and according whether this became thereby positively electrified or only approximately neutralized, the cloud will either in the same instant discharge toward the earth, or not. It may even happen that the earth will violently discharge toward the neutral cloud if the difference of tension is sufficiently large. In every, even only approaching a neutral condition of the cloud, the repellent power within its interior decreases; at the same time, beside gravitations, the large concussion of air, produced by every violent discharge, operates upon the vapor bubbles, unites them into drops of water, which, of course, are impelled by their weight, and fall down to the earth, and thus facilitate in every manner the equalizing of the electricities as well as the passing over of the terrestrial electricity toward the cloud, no matter whether this take place by moderate or violent discharges. It is an accepted fact that flashes of lightning of negative terrestrial electricity toward the clouds are more seldom seen than those of positive normal electricity toward the earth.

Under all conditions, therefore, will the uppermost strata discharge their positive electricity toward the cloud lying between them and the earth, and make it positive; the earth, on its part, makes it alternately negative again, so that a long continued constant interchange of the electricities will take place in that intermediate cloud, as long as the immense accumulation of electricity in the uppermost regions and its tension will permit the violent discharges. It can therefore barely ever occur in a severe thunder storm that rain descends before the corresponding cloud has surrendered the greatest part of its electricity by either gradual or forcible discharges. A very strong and irregular wind might produce some such effect.

The occurrence that, especially after very long continued hot weather, when a warm rain might reasonably be expected, the reverse takes place, viz., that *hail*, consequently lumps of ice, fall down to the earth, is now no longer a puzzle. During the very sultry weather, there are no deep lying intermediary clouds in the vicinity; the conducting air column charged with aqueous vapor mounts into much higher regions and conducts the lightning from this height, in which electricity possesses far greater tension, down to the earth. After the discharges, which under such conditions will also be much stronger, drops of water form at once; they congeal in the lower temperature of those regions, and precipitate as hail, bearing down with them all drops of rain overtaken in their descent, and causing them to congeal also. Only the supposition of an intermediate cloud between the strongly positive normal electricity of the upper atmosphere and the strongly negative electricity of the earth makes the observed irregularities and rapid changes of the positive into negative electricity, and *vice versa*, in the thunder cloud explicable.

The question next occurs, why, with violent thunderstorms, a cloud *never* completely empties itself, so that during rain the sky would *gradually* become clearer. On the contrary, it will always and everywhere be observed that following a thunderstorm, after the rain has ceased, black clouds still hover in the sky, almost as dark as before the tempest. This occurrence can also be explained by the preceding. The discharges from the uppermost strata toward the cloud continue until the tension of the uppermost normal electricity has relaxed somewhat, or until the cloud has descended so far toward the earth that those discharges must cease, in consequence of the increased distance. The rain, however, will continue to be precipitated; in fact, it increases in violence when the electricity of the cloud has become neutralized to as high a state as possible; but it will at the same time promote a very strong passing over of the negative terrestrial electricity into the cloud, and the latter reassumes an electric condition with sufficiently large tension, so that the formation of rain must cease. The negative cloud is next repelled by the negative electricity of the earth; it arises and continues its journey until it attains an elevation in which normal electricity can again discharge into it, whereby the procedure begins anew.

By thunderstorms, therefore, we must imagine a very oft-repeated ascending and descending of the clouds combined with intervening discharges and precipitations, while these clouds scud over the earth, so that, therefore, they now discharge, now pass without rainfall over a locality. It is easiest proved by the more violent hail-bearing thunderstorms, that precipitation is confined to small areas, that the cloud without doing damage passes on, and that only in a more remote locality new and violent precipitations ensue. Since the condition of the often mentioned conducting air column has a great influence, it is very possible that the second discharge of the same cloud be more violent than the first; still, the intensity of a cloud will in general gradually decrease, because its water percentage diminishes by the discharge of rain. The air column can gradually discharge a feebly positive cloud, and charge it with the negative electricity of the earth, even before flashes of lightning are seen. The electricity issuing from the ground before thunderstorms, the St. Elmo's fire, etc., are given as proof of this.

We do not by any means exclude hereby the development of electricity in the moderate zone, by the friction of the clouds on the earth; this will always be the case, and more so in hot than in cold weather, because hot air is capable of absorbing more moisture. But the generating planes are not as large, wherefore the electricities can easily reunite outside of them. The air currents, also, have seldom so direct an upward tendency that such equalization could not take place easily, especially with the strong vapor charged air of summer. The fogs with their positive electricity confirm that even with the smallest friction of humid air on the earth positive electricity can develop in the former, even if only feebly. And similarly to those clouds and the uppermost atmosphere, fog can also better retain the electricity in winter, since only very warm, humid air becomes conductive, but not the colder, during which fogs form.

As is known, the electricity of precipitations is sometimes positive, sometimes negative. It requires no proof to show that positive electricity predominates during thunderstorms, since the cloud, during the discharges, mostly shows an excess of positive electricity, also the frequent change of the electric tensions, which becomes noticeable with the rains accompanying thunderstorms. By common rain without violent discharges, rather a negative tension becomes noticeable. The reason for this is as follows: The negative electricity of the precipitations is generally derived from clouds that have already assisted in a thunder-storm, but were drifted so far to the north that sudden discharges are no longer possible, on account of the diminished water percentage of the air and the decrease of tension of the normal electricity. After the preceding explanations, it must be accepted that by the occurrences of thunderstorms the normal electricity is consumed in greater part, and that only a small portion of it arrives at the north pole in summer, so that under ordinary circumstances a northern light can no longer arise here. Now, when the tension in the uppermost region under a certain degree of latitude has become sufficiently weak, and yet clouds have drifted so far to the north, they then must surrender this negative electricity obtained from former thunderstorms, in consequence of other causes, such as differences of temperature, the winds, etc., and most of the rains with negative electricity will therefore come from the south. The positive rains come more frequently from the north, and manifestly bring with them their positive electricity, generated by friction with the earth. Very frequent exceptions from these rules will result from the winds, which in different regions may have entirely opposite directions, also from the fact that mountain chains,

and the winds very frequently influenced by them, must have a large, often a predominating, influence upon the formation of the precipitations when no violent electric discharge can occur.

I will only say a few words about the periodical deviations of the normal electricity. Their connection with the terrestrial magnetism is confirmed in a striking manner by the similarity of their periodical deviations. Both have two maxima and two minima in their diurnal variations as well as their annual periods. The corresponding maxima and minima cannot at the same time become manifest, because the terrestrial magnetism does not depend upon the normal electricity of one point of observation, but upon that contained upon the entire surface of the earth.

As an additional proof of the generation of electricities by the friction of aqueous vapors on the earth, and at the same time for the plainer comparison with the steam boiler electricity, I will cite the occurrence of a *volcanic eruption*, when, as is well proved, very violent electric discharges follow immediately upon the eruption, and heavy rainfalls ensue at once. Cause and effect lie extraordinarily close together here. Since the generating plane, the crater, is very small, the recompensation can very quickly take place at a short distance from the former. But if with so small a generating plane electricity can be developed for such powerful thunder storms, how extraordinarily large then must be the totality of the electricity generated by friction upon the entire terrestrial surface!

Still another important occurrence must be briefly mentioned here: The influence of the *sun spots* upon the northern light, the magnetic needle, etc. When I call up for consideration that the years of the sun spots are accompanied by the hottest summers and mildest winters, together with the strongest changes of temperature, and that in hotter days more electricity is also generated, of sufficient tension and quantity to also produce a northern light even in warmer months, and to exert a very sensible influence upon the terrestrial magnetism, all irregularities are explained by the preceding.

I anticipate the following objection to my hypothesis: If the electricity of the atmosphere in the hot zone is really generated in such extraordinary quantities, and is transported from thence through the highest regions to the poles, why, then, do no clouds form from the great quantities of aqueous vapor, by which the ever-progressing currents of air of those strata is rendered visible? The answer is simply: Because the tension of the electricity adhering to these water particles is so strong, that the repellent electric forces acting upon them are greater than the attracting (gravitation) forces, as was explained at the formation of the clouds. The electric tension of the aqueous vapor is so strong that the concentration of the vapor in bubbles or drops becomes impossible; on the contrary, it must reduce the water into the finest particles, the layer must expand over the entire surface of the atmosphere, and become thoroughly transparent. When very large discharges have occurred after thunderstorms, of course the aqueous vapor must concentrate on account of loss of tension, descend into lower regions, and become visible as a light cloud, which increases in darkness with the depth of its descent and the size of its water globules. I called the uppermost layer of the atmosphere, which is the vehicle of the normal electricity, transparent, but not invisible. To what other agent than this uppermost region, strongly charged with water and electricity, do we owe the admirable blue color of the sky, which color becomes more decidedly pronounced with the increase of tension of the normal electricity? The visibility of the aqueous vapor bearing the normal electricity is besides this supported by the observations of the brighter glittering of the stars in times of sun spots, etc. Without such currents of finest-divided aqueous vapor no glittering whatever could occur, even by the clearest sky.

The objection why electricity could, in general, maintain itself in the uppermost regions as far as the poles, and why not previously become equalized by attraction with negative terrestrial electricity, would be entirely unfounded. When the surface of the earth is heated more or less, and the air becomes conductive even to a trifling degree, without, however, that it becomes strongly repellent as a generating plane, discharges will take place, even if only gradual, according to circumstances. But where, as is the case upon the opposite hemisphere, this condition of conductivity of the air is wanting, in consequence of the unduly great cold, the entire atmosphere may be regarded as a non-conducting sphere with a conducting thin layer upon the surface. The equal-named electricity of this stratum repels itself everywhere, and would be able to discharge to the earth from every point, if other co-operating causes—the above described ones—would not more exactly determine the locality of the discharges.

[ENGLISH MECHANIC.]

A NEW ASTRAL PHOTOMETER.

THE necessity that has arisen of late for some photometer to measure the light of the stars with, has been met by two inventions. The first was Professor Pickering's photometer in America; the second was by an application of, I think, Dawes' method of a wedge of neutral tinted glass, by Professor Prichard. Both photometers are valuable, but they have two disadvantages. First, they are far too expensive to be possessed by amateurs, both being priced at about £15, and secondly, they require an equatorial and a clockwork motion. Having felt very much of late the necessity of some more simple method, I commenced making some trials with various contrivances, but for some time without any prospect of success. It is astonishing how accident helps one sometimes. For one evening a temporary disarrangement of the illuminating apparatus took place, and left me with a field half light and half dark, while the star at which I was looking was so far out of focus as to be a disk, which was invisible in the bright field. Let me first try and describe my illuminating apparatus. It is all home-made, very rough, but it answers its purpose, which is the chief thing. It consists of a prism placed behind one of the stops of the telescope. It is fastened into the tube of the telescope. This prism I made for myself by cutting it out of a thick piece of plate glass. Fixing it into the telescope was a matter of difficulty; but a friend here came to my rescue, and fastened it in securely with a mixture of pulp made of paper and glue. By this prism the light is totally reflected from a lamp outside down to the eyepiece end of the telescope. The lamp is a small one, burning ordinary mineral oil. The method of fixing it to the telescope deserves a word or two. It is placed in a basket of copper wire, the ends of which are bent (Fig. 4, W W) and pass through two pieces of wire, C C, by the little curve in the wire at S. The pieces of wire are continued and bound round the tube of the telescope. They lie immediately below the prism, while the flame only just shows above them, so that the moving of the telescope in altitude never destroys the action of the prism. A counterpoise of lead is fastened on to the basket (Fig. 4, A) to keep it in an upright position. The covering for the lamp was a great difficulty, for it was necessary to have it light in weight, opaque at all places save one, and of such a nature that the wind should not affect the light. An old taper-box furnished this. The top was bent to the shape of B in Fig. 5, while a piece of glass was fixed to a hole at G, and the box fitted on to the lamp at A. There was no danger of this taking fire, because only the smallest flame is needed, and I have used it for nearly a year and am quite satisfied with it. I hope these

FIG. 1.

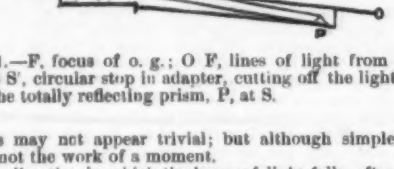


Fig. 1.—F, focus of o. g.; O F, lines of light from o. g.; S S', circular stop in adapter, cutting off the light from the totally reflecting prism, P, at S.

things may not appear trivial; but although simple, they were not the work of a moment.

The direction in which the beam of light falls after leaving the prism is shown in Fig. 1, where P is the prism, and P S P S' the beams of light from the prism. The light from the object glass is shown by O F O. The outer lines represent the conical tube of the telescope. From this diagram it will be seen that the light from the prism falls in a ray inclined at a small angle to the optical axis of the telescope. Hence it is possible to stop out a portion of the lamp light without interfering with the light from the object glass. This is accomplished by a circular stop, S', placed at the end of the adapter. It will be seen at once that this makes a circular disk of light in the field of view.

When the lamp is lighted, the field appears as in Fig. 2, where the stars are supposed to be in focus. The bright disk is shown by B B, the shaded portion in the drawing. The stars will be readily seen through this when in focus; but if the adapter be pulled out the stars are no longer points, but disks of light, and the brighter the stars the brighter the disks will be. Now so long as the star disks are brighter than our artificial disk of light, they will be seen through it; but by pulling out the tube we enlarge the star disk, and decrease its brightness therefore. And so a point will be reached where the star disk can no longer be seen through our artificial disk of light. The brighter the star the further the tube must be drawn out. Fig. 6 is the adapter carrying the eyepiece and marked with a scale to $\frac{1}{10}$ in. The intervals between each tenth can be estimated in decimal parts, each tenth being subdivided by estimation into ten parts again. Now, as to the method of using it, let A and B be two comparison stars above and below the variable, and V the variable; measure A's point of disappearance, let it equal x, and in like manner B, and let it equal y, then the difference of magnitude between A and B will equal $x - y$; measure V and let it equal z, when V Magnitude will be $x - z$. The value of $\frac{1}{10}$ of a magnitude in the divisions will be found from $(x - y) / (A - B)$, where A and B represent the true magnitudes of the two stars. The value $x - z$ will then easily be found by proportion, and the true magnitude of the variable will be A ± that value so found.

FIG. 2.

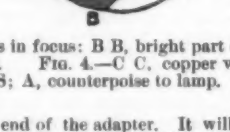


FIG. 3.

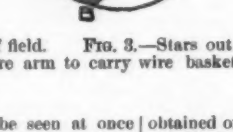


FIG. 4.

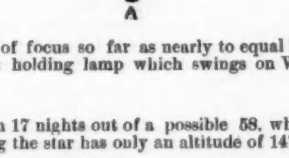


FIG. 2.—Stars in focus: B B, bright part of field. FIG. 3.—Stars out of focus so far as nearly to equal bright part of field B B. FIG. 4.—C C, copper wire arm to carry wire basket holding lamp which swings on W W, passing through S; A, counterpoise to lamp.

To give a practical example: on June 1, γ Hydræ was measured as star A, and the result found to be 35·75, and ψ Hydræ was measured as B, and found to be 10·95; $x - y$ would, therefore, equal 24·85. The variable R Hydræ was then measured, and found to be 14·35, and the magnitude would thus be $x - z = 35·75 - 14·35 = 21·40$. γ Hydræ is of the 3·2 magnitude, and ψ is of the 5·3 magnitude; A — B will, therefore, equal 3·2 — 5·3 = 2·1 magnitudes. Then $(x - y) / (A - B) = 24·85 / 2·1$ mag., and $\frac{1}{10}$ mag. = 1·18. From this the true magnitude of R Hydræ, represented by 21·40, can be found by the proportion

Scale.	Scale.	Mag.
1·18	21·40	0·1

and this, added to 3·2 (the mag. of γ) will give, as the true magnitude of R Hydræ, 5·01.

The results with this photometer have exceeded my expectations. The measures were usually made in two sets of three measures. It would be impossible to give here more than an example of these. The difference is very rarely 0·1 of a magnitude. Taking all the double measures of LL 14599, we have:

	1.	2.	Differ.
Feb. 28	6·47	6·47	0·00
March 26	6·55	6·50	0·05
" 30	6·49	6·53	0·04
" 31	6·52	6·54	0·02

while the measures themselves in the extremes only differ by 0·08 and 0·07, and the mean magnitudes derived from both are 6·507 and 6·510, with a difference of 0·003. The same star was measured in all on fourteen nights between Feb. 14 and April 6, and the greatest difference is only 0·24. The star LL 14706 was measured on eight nights, with a difference between the extremes of only 0·10, and rejecting one night with a difference of only 0·05. The comparison stars differed by one magnitude, being of the 6·0 and 7·0 respectively.

The photometer has only been in use since the middle of February, and doubtless experience with it will further reduce the differences.

In construction it is so simple that it will not cost half as many shillings as the other costs pounds. The climate here is very wonderful. From February to the end of May observations were obtained on 47 out of 120 nights, and could have been obtained on at least three more but for loss by unavoidable circumstances. Measures of R Hydræ were obtained on 17 nights out of a possible 58, which is good, considering the star has only an altitude of 14° at meridan passage.

The aperture of the telescope can be reduced for the brighter stars by cardboard stops. To avoid the loss of time in changing these, a simple contrivance was made to close the aperture from the eyepiece end. Two arms project before the o. g., carrying a disk of cardboard rather larger than the aperture, and moving on a wire axis (Fig. 7). At the top of this axis is a wire arm. A flexible rod made of wire moves this arm from the eyepiece end by a handle which can be pushed up and down. When open, hardly any light is lost, and it can be closed to any extent at pleasure. The handle is divided in a scale of tenths of an inch, so that the same aperture can be used night after night.

Unfortunately, when the stars are placed out of focus, the image is a circle of light with a dark center. But the apparatus, though not used with the photometer, is handy and easily constructed, and useful of itself.

I must now close this long letter, which I trust may have been not without use to some of "ours."

T. E. ESPIN.

Observatory of the Liverpool Astronomical Society, Church-road, West Kirby.

FIG. 5.

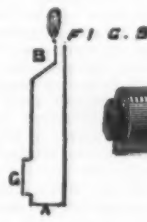


Fig. 5.—Section of lamp shade made of cardboard. G, piece of glass to allow the light to pass to the prism.

FIG. 6

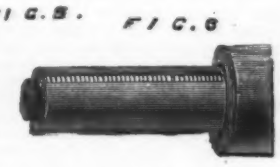
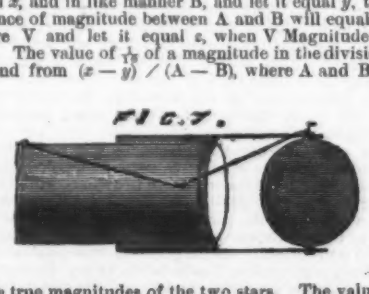


Fig. 6.—The eyepiece end of the telescope, showing adapter and scale.

FIG. 7.



SIR EDWARD SABINE.

THE death last week, at Richmond, of General Sir Edward Sabine, ex-President of the Royal Society, at an age which only lacks five years of a century, carries us back to a time which, from the standpoint of science at least, is a very remote period. He was, we find to our surprise, some sixty years ago working in the company of such men as Wollaston, John Dalton, Peter Barlow, Pond, the Astronomer Royal, Mr. Airy, and Mr. Owen, while the activity of his life was maintained to make him a contemporary of such men as Spottiswoode, Cayley, Huxley, Tyndall, and others. He was born in Dublin, October 14, 1788; his family is stated to have come originally from Italy, but latterly to have been settled in Normandy. He was trained at the Royal Military Colleges of Marlow and Woolwich, and obtained his commission in 1803, and received his captaincy in 1813. Much active service he does not appear to have seen, the main event in his military career being in connection with the campaign against the United States—1813-16—when, in 1814, he commanded the batteries at the siege of Fort Erie. He was later on, about half a century ago—1830—on duty in Ireland during the disturbances of that time. He became Lieutenant-Colonel in 1841, Lieutenant-General in 1859, and he retired with the rank of General in 1874.

Very early in his life he took the greatest interest in physical science, especially in the subject of terrestrial magnetism; and a reference to the "Philosophical Transactions" of the Royal Society will show how indefatigably he pursued this branch of experimental science throughout the rest of his life. During the American campaign he distinguished himself by exceeding his orders; but the offense was forgiven through the brilliancy of the result which attended it. The war concluded, he was appointed astronomer in Ross' Arctic expedition in 1818, and accompanied Parry's expedition in 1819-20 in the same capacity. For the next few years he was employed by the Government to make pendulum experiments near the equator and in the north, and he published the results in 1824. In 1825 he was appointed with Sir John Herschel the British member of a joint commission between the French and English Governments, to determine the precise difference of longitude between the observatories of Paris and Greenwich, by means of rocket signals; and in

1827 he was engaged in determining by direct observation the difference in the lengths of the seconds pendulum at Paris and at Greenwich, and of the magnetic force of the earth at those two stations. For many years after this, to verify his theories and complete his knowledge, he carried on experiments in magnetism, and with the pendulum in different latitudes in all parts of the globe, from the equator to the Arctic Circle, and regular reports were sent to the Royal Society and the British Association.

In 1836 and 1837 he presented to the British Association an account of a magnetic survey of the British Islands, and a report of the variations of the magnetic force in different parts of the globe. Again, in 1849, he still deals with the great subject of terrestrial magnetism, and thirty-two years later he was working in the same direction, and in 1872 we find him bringing before the Royal Society his thirteenth contribution on the subject of terrestrial magnetism. It is not improbable that Sabine had no distinct idea of simply benefiting navigation by his researches, immeasurably good and satisfactory as such an idea would have been, but of pursuing science for its own sake, for the mere desire of adding to a correct knowledge of the multifarious phenomena of our wonderful universe.

A result of his report for 1838 was the dispatch of Captain James Ross, in command of the Erebus and Terror, to make an energetic survey of the Antarctic region; and three meteorological observatories were established at St. Helena, the Cape, and Van Diemen's Land. The reports were sent home and the results were reduced and published; and among other relations which Sabine did much to establish, were those between certain magnetic phenomena and sunspots, and the influence of the magnetic action of the sun and moon upon the earth. Nor must we forget to point out the good results which follow from the pendulum experiments, to which we owe our present conception of the exact figure of the earth.

Sabine was elected to the Royal Society so long ago as 1818, was chosen a vice-president in 1850, and succeeded the late Sir Benjamin Brodie in the presidency in 1861. He held the post for several years, and as late as 1870 presided at one of the *conversazioni*. In 1879 he lost the accomplished and congenial wife whom he had married upward of half a century before. She it was who translated Humboldt's "Kosmos," which he edited in 1849–58.

He was made K.C.B. in 1869, had the Prussian order *pour le merite*, the Italian of Sts. Mauris and Lazaro, and the Brazilian of the Rose. He had received the Copley and Royal medals, and had been elected corresponding member of many of the principal academies and societies of Europe and America. The name of Sabine will ever hold a high place in the annals of science and the history of navigation.
—*The Engineer.*

MILITARY BALLOONING.

A LECTURE on this subject was recently delivered at the Royal United Service Institution by Lieutenant B. Baden Powell, Scots Guards. In dealing with the subject, the lecturer first entered into the history of balloons as used in actual warfare; of experiments conducted on the subject; of the causes of success and failure in ascents; the relative advantages and disadvantages of captive and free balloons; the means and methods of inflation; and the question of navigating balloons.

Balloons, the lecturer points out, may be used in warfare for the following purposes:

They may be carried with advanced parties and sent up to ascertain the position of the enemy and the nature of the country ahead.

They may be employed to reconnoiter the enemy's position previous to a battle.

They may be utilized in noting the formation and movement of the troops and position of the reserves during an engagement.

They could often be beneficially employed as sentries on outpost duty, and would be exceedingly useful during sieges.

They may often prove invaluable for escape, communication, or signaling, when other means fail.

The first balloon which ascended in public was launched by Montgolfier in 1783, and in 1793 the French instituted some experiments on the subject. The following year a regular balloon corps was formed, composed as follows: 1 captain, 1 sergeant-major, 1 sergeant, 2 corporals, and 20 men, half of whom at least were experienced in the trades necessary for balloon service, viz., masonry, carpentry, painting, chemistry, etc. These men were termed "aerostiers," and were armed with a sword and two pistols each, being entirely subject to military discipline during the time they were in the field. Several balloons for these aerostiers were made of specially manufactured Lyons silk, and were so efficiently varnished that they were said to have remained inflated for three or four months. The first was twenty-seven feet in diameter and could support 500 lb., 10 lb. to 20 lb. of ballast being taken in the car. The balloons were held captive by two cords fixed to the equator by network, and which allowed them to rise about 1,500 feet. For transporting the balloon twenty cords were fixed to the equator by triangular pieces of netting to equalize the strain, and one man was told off to each cord to tow it along. At night it was snugly secured under a large piece of sailcloth. There being a difficulty at the time in procuring sulphuric acid, the hydrogen was produced by passing steam over red-hot iron, and a furnace was built which after many trials was capable of producing sufficient gas to fill the balloon in four hours. Communication was kept up by flags, and by notes thrown overboard tied to sand-bags or loaded arrows. These balloons all did good service at the battle of Fleurus; two ascents were made, each of four or five hours, notwithstanding a strong wind. All the movements of the enemy were observed and reported, and the success of the French at this battle is said to have been greatly due to the aid of this balloon. It was found to be preferable to attach the cable to horses or men rather than to fixed objects, as the strain on the balloon was thus considerably lessened.

During the siege at Mainz in 1799, Coutelle made some ascents during a very strong wind. He writes: "I was at more than 1,000 feet from the ground, when three successive squalls knocked me to the ground with such rapidity and force that many of the bars that strengthened the bottom of the car were broken. On each occasion the balloon rose with such force and rapidity that thirty-two men at each rope were dragged some distance." He nevertheless managed to count the enemy's force. The Austrians even went the length of sending out a flag of truce to request Coutelle to descend from his perilous position. This shows that a balloon reconnoissance is possible even in a high wind.

In 1812 the Russians constructed a huge balloon at Moscow to carry fifty persons, which was to hover over the French army and rain shells and projectiles. The balloon, however, refused to rise from the ground. In the Civil War in America several balloons were used. On October 4, 1861, an aeronaut named La Mountain ascended in a balloon from McClellan's camp on the Potomac. He cut the retaining rope and ascended to a height of 1½ miles, when he drifted over the enemy's lines. After observing all their positions and movements, he rose into another current of air and descended safely within his own lines. Later on the Federals instituted a regular balloon corps, of which Colonel Beaumont, R.E., has written an interesting account in the Royal Engineer professional papers.

The first military balloon experiments in England took place in July, 1862, at Aldershot.

In the Franco-German war the Germans tried balloons, but the system was not satisfactory, and little good was done. During the siege of Paris balloons were used in a more extensive manner. Two were employed as observatories to watch the enemy. Larger balloons were then constructed. They were made of strong cambric, oiled, and of about 70,000 cubic feet capacity, and cost about 160*l.* each. They were filled with coal gas, and could carry a load of 2,000 lb., including 600 lb. ballast and about 1,000 lb. dispatches. The first of these, the Armande-Barbe, bore Gambetta beyond the reach of the Germans. During four months sixty-six balloons left Paris, of which fifty-four were specially constructed for the administration of posts and telegraphs. About one hundred and sixty persons were carried over the Prussian lines. Of the aeronauts in charge only twelve were professionals, the remainder being chiefly sailors and acrobats.

In June, 1871, an English committee was appointed to inquire into the use of balloons for warfare. In April, 1879, an official balloon committee was instituted in England. Experiments were conducted at Woolwich, and four balloons were made of specially woven fine calico, varnished. The hydrogen was made by passing steam over red hot turnings. One of the balloons was tried free at a review at Woolwich, but failed, owing to the wind being unfavorable. The next year another was worked very successfully at the Brighton review. In September, 1880, the War Office detailed a whole company of engineers for instruction in ballooning at Aldershot, and many experiments were made. Meanwhile, the French Government have established a military aeronautical school. Their balloons are spherical, ten meters in diameter, of best silk, varnished with a special varnish which keeps them very gas-tight. A liquid which does not readily freeze is used as ballast, so that the discharge can be nicely regulated. English military ballooning received a sudden check with the accident to the War Office balloon Saladin, in December, 1881, but when the Egyptian campaign commenced a balloon equipment was to be sent out. However, this could not be got ready before the decisive battle was fought, and so we have lost the opportunity of gaining experience as to their use, not to mention the assistance they might have rendered in the campaign.

From the experiences quoted above the lecturer drew the conclusion that whenever a regular organized and specially prepared balloon equipment has been employed it has worked satisfactorily, and he suggested that more than one balloon should be employed for observation. He quoted a paper by Major Grover, who raises the following objections to the employment of balloons in war:

1. The chance of their being wrecked by projectiles.
2. Difficulty of transporting the apparatus.
3. Difficulty of providing gas.
4. Difficulty of obtaining good trained aeronauts.
5. Dangers of ballooning.
6. Obstruction of view by smoke and otherwise.
7. Difficulty of management in rough weather, and motion of balloon unfavorable for observation.

Lieutenant Powell answered these objections somewhat as follows:

1. The balloon would as a rule be behind the first line, making it hard to hit, and probably not much attention would be paid to it. If not badly hit, it could be repaired; and even in the case of a shell bursting just in front of it, it would probably descend slowly enough to insure the safety of the inmates. He gave an instance of a balloon 800 feet up, which was fired at by an eight-inch howitzer. The shell burst just in front, and the balloon took fifteen minutes to descend.

2. The transport has been so simplified that balloon accessories and filling apparatus can be easily carried in one or two wagons.

3. Balloons can remain inflated for a long time. The old Fleurus balloon remained full for a month, making continual ascents, and undergoing the rough usage of war.

4. It is not absolutely necessary for a man to be a trained aeronaut from his birth; any man can learn the work. Instance the Paris balloons. Good draughtsmen should be trained to the work, as they would then be useful in both capacities.

5. Dangers of ballooning are much exaggerated. The deaths that have occurred are not more than 1 in 1,000 ascents, and good aeronauts have made over 1,000 ascents without accident. Accidents are principally due to passengers being thrown out or jumping out of the car on concussion with the ground when descending with a strong wind.

6. The lecturer quoted from his own experience that the smoke from guns does not obscure the view, except perhaps on a very calm day.

7. Balloons can be employed in very rough weather, as was shown by the French war balloons of 1793 described above. The lecturer was himself up in a captive balloon at the last volunteer review in a very stormy southwest breeze, and was enabled to use his field-glasses, and obtain a very good view of the field of operations.

Captive balloons are no doubt the most suitable for war purposes. They are independent of the direction of the wind, can be hauled down without loss of gas, and communication can be easily kept up. A strong wind is the great enemy to captive balloons. A long cylindrical shape has been suggested. The French tried one in 1793, but apparently it was not successful. It has the following advantages over the usual shape:

It may be filled and kept sheltered from wind and from the enemy's sight. It is easier to transport in a wind or through forests. It can be towed better, and would be steadier for observation.

Small balloons retained by a string have been used for taking plans of the country beneath, by instantaneous photography, an electric wire connecting the apparatus with the ground. Many experiments have lately been made in this direction. Free balloons require much less ascensional force than captive ones, as they have no weight of rope to carry, and no wind to withstand. They are steadier when up, and less liable to be hit by shot. The wind can generally be utilized by working properly. Finally, adverse currents can be made useful, as was done in the American war. A small satellite balloon, weighted as required, and retained by a line, say 1,000 feet long, is useful for ascertaining the direction of neighboring currents of air.

The lecturer's father, the late Professor Baden Powell, suggested small balloons for scientific use with Sir John Franklin's fatal polar expedition. There was no time to prepare them then, but later on, when Sir James Ross was sent out on the search expedition, balloons were utilized. The following are the particulars:

Balloons were first used in the Arctic regions in 1850, in the Arctic searching expedition under Captain Horatio Austin, for the purpose of distributing papers containing information of the whereabouts of our ships, and the depots of provisions. These printed colored papers were tied in little bundles to a slow match which was attached to the balloon, and as the slow match burnt the papers were set free. Forty-two balloons were taken; silk, 8 feet to 5 feet in diameter, and they cost 16*l.* The hydrogen gas used was generated by sulphuric acid and granulated zinc.

The ascensional power of a balloon is obtained by rendering it lighter than the displaced volume of air. This is accomplished either by filling it with a lighter gas or heating the air inside so as to make it expand. Hydrogen, being the lightest gas known, is the best for inflating balloons. The objection to it is that it is more expensive, and being more subtle, is harder to retain than coal gas. Its rate of diffusion is about 2½ times greater than coal gas; 60 lb. to 70 lb. may be taken as the lifting power of 1,000 cubic feet of hydrogen.

Hydrogen is usually produced by the action of dilute sulphuric acid on iron or zinc; 350 lb. of iron are required to produce 1,000 cubic feet of hydrogen. The gas thus produced costs about 1*l.* 5s. per 1,000 cubic feet. A good portable apparatus will fill a balloon of 6,000 cubic feet capacity in four hours. Another method of producing hydrogen is by the action of steam on red-hot iron. This gives a lighter gas. The oxygen of the steam combines with the iron, and the hydrogen is liberated; this is the method adopted by our own engineers. The most simple and rapid plan, though practically useless on account of the expense, is by placing a piece of sodium in water, when about 700 times its volume is at once given off. The metal at present costs 5s. a pound, so that 1,000 cubic feet of gas would cost 22*l.* Hydrogen may also be obtained by passing a current of electricity through water. Coal gas, when it can be employed, is more convenient; its lifting power is 35 lb. per 1,000 cubic feet of gas.

The original system of Montgolfier of inflating a balloon by rarefying the air within it by heat, is so simple and rapid that it at once suggests itself as suitable for war balloons. But on the other hand its lifting power (25 lb. to 30 lb. per 1,000 cubic feet) is small, and it is so difficult to retain such a balloon captive, while the danger of catching fire is so great, that it has not been found serviceable in practice. A balloon is generally made of cotton or silk, covered with a varnish chiefly composed of boiled linseed oil, and often containing India-rubber. Balloons have been made of mackintosh, gold-beater's skin, and even copper. The weight of the material of an ordinary balloon is about 0·02 lb. to 0·05 lb. per square foot. The cordage has been sometimes made of silk in order to be light and strong.

There are two general principles on which it has been attempted to navigate balloons; 1st, by utilizing the different currents of air; 2d, by mechanical propulsion. The first requires perpetual rise and fall of the balloon, which means an expenditure of gas and ballast, the life and blood of the balloon. The lecturer suggested the use of a powerful safety lamp, in order to expand the gas when required. In a balloon of 25,000 cubic feet, raising the temperature 1 deg. would be equivalent to discharging 4 lb. of ballast.

Several experiments have been carried out in the direction of propulsion for balloons, and some very partial success has been obtained, but none giving much encouragement. The lecturer concluded his interesting paper by quoting Carlyle's words, which he feared for the present must remain true: "Beautiful invention; mounting heavenward, so beautifully, so unguidably! emblem of much, and our age of hope itself!" In the discussion which followed, Major Templer said he did not consider the system proposed by the lecturer of raising or lowering the balloon by varying the temperature of the gas practicable. He stated that his experience had taught him that the gas used for inflation should be kept at as constant a temperature as possible, and that the alterations in temperature proposed would have the effect of wasting the gas more than the discharging of gas and ballast. As far as the conveyance of the balloon accessories were concerned, a two-horse wagon should be able to take the gas generator. He stated the weight of the present French equipment to be 2 tons 6 cwt., and the capacity of the balloons to be 1,700 cubic feet. Captain Lee considered that failures in ballooning were due, to a great extent, to small details being neglected, and insisted upon the necessity of careful and accurate training. Balloons in warfare should never be expected to move about very much, and he protested against generals in command expecting them to be as handy as light cavalry. He explained that the Committee at Woolwich were endeavoring to lighten the balloons by making them of bullock's intestines; the difficulty experienced in the use of this material being to get it to stand the folding and packing necessary for transportation. He considered that captive balloons should be made as small as possible in order to lessen their resistance. Colonel Beaumont considered that the lecturer was inclined to pass over the difficulties. The reason that balloons have not been more used, was the difficulty of providing them with a motive power. He pointed out that this difficulty lay in the fact of there being comparatively no fulcrum for the propelling lever to act against, and stated that an effective engine for balloon propelling purposes would require to give to give ten times the power of any engine yet invented, weight for weight. He considered that balloons would be very useful in sieges for taking photographs, but that the difficulty in taking a series of photographs is not so much the adjustment of the lens as that of keeping the balloon at the same height. He thought that a balloon was a very bad means of conveyance on account of its limited carrying capacity, and that it would be more useful to convey intelligence into a besieged town than to carry people out of it. In order to do this, however, it would be necessary that it should have some propelling power. The lecturer, in answering the objections raised, said that one horse-power could be obtained for a weight of 50 lb., and that there was very little chance of two balloons

approaching one another, as if captive they would necessarily be moored at some distance apart, while if free the chances were almost as great that they could not close one another.

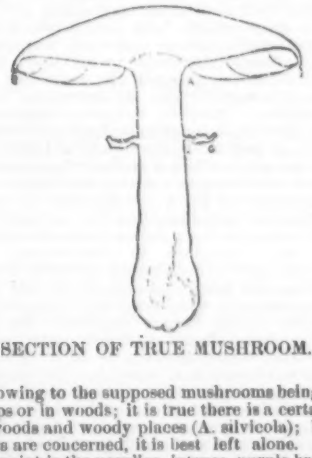
The Chairman, in summing up, said that one of the great difficulties in ballooning was that the balloonists became like the balloons themselves, flighty, and were apt to overlook practical difficulties. He did not consider that balloons were applicable to the ordinary conditions of warfare, but would be very useful in sieges. He considered that the lecturer had understated the weight necessary to be transported. He himself put it down at 5 tons. He said that balloons would have been of no use in Egypt, as it would have been impossible to have transported the weight over the desert. When a portable propelling machine can be arranged, then balloons may have a future.

With reference to the uses to which the lecturer considered that balloons might be put, we think that in the present stage of knowledge, and considering the unwieldiness of a balloon and its belongings, it would certainly be rash (to say the least of it) to utilize it for outpost work, or in the fore-front of a battle. Of the historical view little need be said, except that great thanks are due to the lecturer for laying it all so concisely before the public. There appears to be no doubt that at present we must be content with captive balloons, and of the advantages of these for observation there can scarcely be much difference of opinion. From the data given by the lecturer, coal gas would appear to be on the whole the most suitable for inflation. With reference to Sir Charles Nugent's opinion that balloons would have been useless in Egypt, we have the opinions of officers who were out there, that they would, on the contrary, have been of great assistance. It must be remembered that very shortly after our landing at Ismailia the railway was in working order, and though the difficulty in obtaining engines prevented all the stores being transported by rail, yet there is no doubt that room could have been easily found for one or more balloons, and the advantage of having an uninterrupted view of the enemy must be very apparent. A balloon sent up from Alexandria would have overlooked all the enemy's lines at Kafir Dowar.

MUSHROOMS.

THE true mushroom (Agaricus campestris) is invariably found among grass in rich open pastures, and never on or about stumps, or in woods. Many cases of poisoning have

TRUE MUSHROOM (AGARICUS CAMPESTRIS).



SECTION OF TRUE MUSHROOM.

occurred, owing to the supposed mushrooms being gathered from stumps or in woods; it is true there is a certain variety found in woods and woody places (A. silvicola); but, as far as amateurs are concerned, it is best left alone. A second very good point is the peculiar, intense purple-brown color of the spores (which are analogous to seeds); the ripe and fully mature mushroom derives the intense purple-brown color (almost black) of its gills from the presence of these innumerable colored spores. To see these spores, and so become acquainted with the peculiar color, remove the stem from a mushroom, and lay the upper portion, with the gills lowermost, on a sheet of writing paper; in a few hours the spores will be deposited in a thick, dark, impalpable powder. Several dangerous species at times mistaken for this mushroom, have these spores umber-brown or pale umber-brown in color, and belong to Pholiota or Hebeloma. In the accompanying figure is shown a vertical section of the true mushroom, which differs (when the color of the spores is taken into consideration) from almost all other Agarics, and certainly from all poisonous ones. One of the principal points to be observed is the distinct and perfect collar at C, quite encircling the stem, and the edge of cap at B, overlapping the gills; in some poisonous allies, as A. æruginosus (generally found on and about stumps), this ring is reduced to a mere fringe, and the overlapping margin is absent, or reduced to a few mere white flecks or scales. Lastly, the gills never reach or touch the stem, A, for, on inverting a mushroom, a blank space will be seen all around the top of the stem where the gills are free from the stalk. There are innumerable varieties of the true mushroom and of the horse mushroom, but all are equally good for the table; sometimes the top is white and soft, like kid leather; at other times it is dark brown and scaly. Sometimes, on being cut or broken, the mushroom changes color to yellow, or even blood-red; at other times no change whatever takes place. But observe, the mushroom always grows in pastures; always has dark, purple-brown spores; always has a perfect encircling clothy collar; and always gills which do not touch the stem, and a top with an overlapping edge.—*The Garden*.

THE BIG TREES OF CALIFORNIA.

OF all sections of the United States, the most interesting and the best endowed by nature is California, situated between the 33° and 42° of latitude. When, after traversing in the famous Pullman cars the immense plains that extend from Omaha to the Sierra Nevada, over an extent of 1,800 miles, one reaches, by means of the great Pacific Railroad, Summit—the highest station—he is 7,000 feet above the level of the sea; and, during the very short trip that brings him to San Francisco, he enjoys delicious views that show him that he is entering an exceptional country. This somewhat reminds one of the emotion that he experiences when he leaves the snowy Alps to descend toward the enchanting lakes of northern Italy. In fact, the Sierra Nevada to the east and the Coast Range, or mountains that border on the Pacific, give rise to innumerable water courses which unite from the north to the south in the Sacramento River, and from the south to the north in San Joachim River, and reach the ocean through San Francisco Bay and the famous Golden Gate. There are, really, in the way of water courses, picturesque rocks, mineral springs, and natural curiosities, two or three entire Switzerlands here.

As I am to occupy myself now only with the vegetable

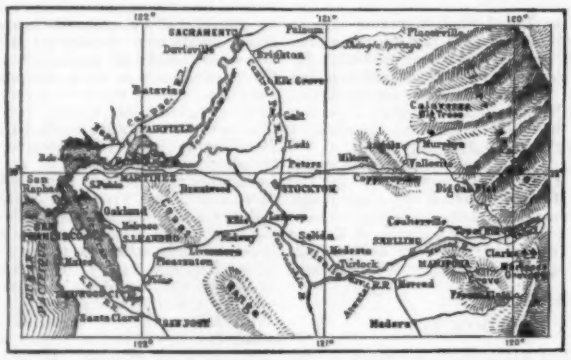


FIG. 1.—MAP SHOWING THE ROUTES FROM SAN FRANCISCO TO THE BIG TREES OF CALIFORNIA.

kingdom, I hasten to say that the mines of gold and silver that in the first place attracted so many emigrants hither are now only a secondary consideration. Agriculture, it will be understood, is here, as it is below, the true, durable, and continuous source of riches. Already, people here are devoting their attention not only to the crops of the center of America, but also to those of the Pacific States, which, thanks to improvements in maritime routes, are sending to Europe a portion of their products. In fifteen or twenty years it will be the same with their wines, which are not held in esteem at present, but the production of which is improving and increasing in immense proportions, because the soil and climate suit them admirably.

I have previously given in *La Nature* a few notes on the fruit production, which is assuming an extraordinary development, and now I propose to visit with my readers one of the greatest botanical curiosities in the world—I mean the *Sequoia* of the Calaveras and Mariposa districts.

The accompanying map (Fig. 1) shows the routes that lead to them. Up to the present time, eight remarkable groups of these trees have been enumerated, but there are two principal ones that especially attract the attention of tourists, and these are the only ones that I shall describe in this place.

The first, the oldest in point of discovery, and the one most easily accessible, is the Calaveras group, which is situated to the east of San Francisco, near the Stanislaus River, and not far from Silver Mountain Pass upon the west slope of the Sierra Nevada. To visit it, one takes the railroad as far as Stockton and Milton, whence a stage coach carries him, over a good road of forty-five miles, through Murphy's to Calaveras. The group of *Sequoia* occupies here a surface of 3,200 feet over a breadth of 700, and contains a hundred prominent trees. One of these, which is divested of its bark up to a height of 116 feet, was shown as a curiosity in the United States, at the London Exhibition in 1855, and finally at Sydenham Palace, where it was destroyed at the time of the burning of one of the wings of that building. At present the highest tree at Calaveras is the "Keystone State," which is 325 feet in height and 45 feet in diameter. Thirty others are to be counted whose diameter varies between 27 and 52 feet, and whose height is between 230 and 320. Their age is variously reckoned at between 1,200 and 1,500 years. The "Father of the Forest," now cut down, measured 450 feet in length and 120 feet in circumference. This entire group is found at an altitude of 4,735 feet above the level of the Pacific.

A passable route communicates at present between Calaveras and the famous Yosemite, through "Big Oak Flat." Let us now say a few words about this wonder that justly attracts all Californian tourists. It was in 1856 that it was discovered, for the first time, by a company of soldiers under command of Captain Boling who were in pursuit of some Indians who had used it as a place of refuge after their depredations. A great deal of incredulity existed at that time in regard to these wonders of nature, and it was not till 1855 that Mr. Hutchings made a serious exploration from the standpoint of the tourist. From that moment the erection of hotels was begun, and now travelers find there all the necessary resources for traversing the country with comfort and security.

One of the wisest of measures was taken by the United States Congress and the State of California as long ago as 1864. In order to preserve to science and for the admiration of travelers the vegetable wonders of the country, a law of the 30th of June gave up to the State a park about fifteen miles long by a thousand in width, starting from the crest of the mountains, upon condition that this portion of the national soil should be reserved for the use and pleasure of the public, and that it should be inalienable forever. The State might authorize the leasing of certain portions of the land for ten years at the most, on condition that the price of such lease should be applied to the preservation and embellishment of certain parts, as well as to the making and keeping in repair of roads leading to them.

There are at present three routes that offer themselves to the choice of tourists: one takes in the Central Pacific Railroad as far as Merced, 115 miles, and then a stage coach through Snelling and Coulterville. The second route, by stage coach, starts also from Merced and traverses Mariposa, and is 95 miles in length.

Finally, the third route and the one most traveled at present starts from Madera station, at 185 miles from San Francisco; and then, by a new coach route, after traversing Clark's Point, one comes within short distance of the group called Fresno Grove and Mariposa Grove, before reaching the Yosemite Valley.

This marvelous valley is situated to the southeast of San Francisco, at a distance of 155 miles by bee-line. It is nearly horizontal over a length of six miles and a breadth of from one-half to one mile.

FIG. 2.—VIEW OF "DEAD GIANT" IN MARIPOSA GROVE.

The Merced River, which traverses it throughout its entire length, receives several water-courses that flow from the mountains which surround it. What especially distinguishes this valley from all others is in the first place the height of the rocks that shut it in almost vertically at heights varying from 3,000 to 6,000 feet, with scarcely any slope at the base. Besides, it offers to the admiration of travelers some exceptional waterfalls and cascades, among the most important of which is that of the Yosemite, which falls from a height of 2,600 feet. The first vertical fall is 1,500 feet in height, then the water flows in a cascade to a depth of 626 feet, and reaches the valley by a fall of 400 feet. The width of the water-course is twenty feet and its depth two feet.

It was in 1853 that the London *Athenæum* and the *Gardeners' Chronicle* spoke of the *Sequoia gigantea* for the first time in Europe, under the name of *Wellingtonia gigantea*. In 1854, Mr. Decaisne presented two specimens of it to the Botanical Society and restored its name of *Sequoia*. Dating from this epoch a considerable quantity of its seeds have been distributed throughout Europe.

After the Calaveras group, the most important one is undoubtedly the Mariposa, which offers, besides, the attraction

FIG. 3.—GIANT SEQUOLÆ IN CALAVERAS GROVE.

that it is in the vicinity of the Yosemite Valley, near Clark's Ranch, at an altitude of 6,500 feet. It is in a small valley, through which flows the Merced River. Here the United States Congress has reserved a space of about two square miles, which contains two distinct groups. Here are found 365 trees, whose dimensions and exact position have been carefully studied and then marked upon official maps. Fire has already made great ravages among them, but there still remain more than 125 trees of a girth of over 40 feet. In the lower group is found the "Grizzly Giant," which is 300 feet in height, 90 feet in circumference at the base, and 64 feet at 12 feet from the surface. Some of its branches are more than six feet in diameter. I give here two figures of Californian *Sequoiæ*. The "Dead Giant" (Fig. 2) has been pierced at the base, and the aperture serves as a passageway for the stage coach. The large engraving (Fig. 3) gives an idea of the general aspect of these giants of the vegetable kingdom, which seem to defy the ages. This calls to mind, in another direction, the emotions that one experiences when, in Upper Egypt, he walks in those immense temples whose material and sculptures strike the tourist with stupor and admiration.

We may recall the fact that the tree having the largest base without a proportionate height is the baobab of Senegal (*Adansonia digitata, L.*); the highest tree that has been made known is the *Eucalyptus amygdalina* of Australia, if we are to believe Baron Von Mueller; but, as regards proportions and form, the *Sequoia gigantea* of California seems to be, up to the present, in the vegetable kingdom, the king of creation.—*Ch. Joly, in La Nature.*

BUCKWHEAT—A NEGLECTED CROP.

CONSIDERING the ease with which it can be raised and the active demand that always exists for it, buckwheat is neglected to a greater extent than any grain produced in this country. In 1881 the entire amount of buckwheat produced in all the States and Territories was only 9,486,200 bushels. The largest crop ever produced was in 1880, when it amounted to 14,617,535 bushels. This crop was produced on 822,802 acres of land, and was worth $8,683,488. About four-fifths of this crop was produced in the States of New York and Pennsylvania. Scarcely any was raised in any of the more southern States, and very little south of Ohio. The greatest yield reported was in Maine, where it averaged twenty-five bushels per acre. It readily sold at $1 per bushel to local millers. Considerable was imported from Canada, where the value of the crop is better appreciated than it is in this country. But a small proportion of the article sold in city markets as buckwheat flour is pure, or true to name. It is generally a mixture of the meal of white corn and various kinds of inferior flour. Millers and dealers often state that it is impossible to procure grain enough to supply the demand for buckwheat flour. In all Northern towns buckwheat cakes are held in high esteem as a breakfast dish. The use of buckwheat in the country is limited, as farmers generally do not raise it, and the flour is not kept for sale by local grocers. Farmers and country millers would do well to take advantage of the demand for genuine buckwheat flour. It will sell readily in town and country at the price the best quality of white winter flour commands, if it is put up in bags weighing from twenty-five to fifty pounds. By judicious management the sales of buckwheat flour could be greatly increased in all parts of the country.

Buckwheat is an excellent article of food for fowls of all kinds. It is also a very good food for hogs and sheep. Bee-keepers cannot afford to be without a field of buckwheat. The blossoms furnish a large amount of honey at a time when little can be obtained from other sources. Soil is not impoverished by raising buckwheat upon it, as it is by raising most kinds of grain. The plants produce a very dense shade during the hottest part of the season, which greatly benefits the soil. The crop can be sown and harvested at a time when other annual crops require little or no attention. Not unfrequently a good yield is obtained from an inverted sod on which a crop of grass has been grown and cut the same season. It is often practical to raise a good crop of buckwheat on land that was too wet to plow and sow early in the season. It may often be raised to advantage where corn or small grain was drowned out. It is the general custom to sow buckwheat on poor land that is very poorly prepared. If a farmer has some land that is too poor or too wet to prepare for any other crop, he is likely to sow buckwheat on it. It is the general opinion that any kind of soil, prepared in any sort of a way, will produce a paying crop of buckwheat. While it is true that it will grow on inferior soil that is poorly prepared, it is also true that more and better grain can be produced on good land that is well prepared as for other grains. In this latitude it is customary to sow buckwheat from the 1st to the 10th of July. It will be ready to harvest before the occurrence of frost. It may be cut with a sickle, cradle, mowing machine, or common scythe. It is easily thrashed with a hand-flail. If hens are allowed to run over the land after the crop is harvested, they will pick up most of the grains that have fallen from the stalks.—*Chicago Tribune.*

BLANCHING CELERY.

IN answer to occasional inquiries, we give the mode of blanching celery which we find best on the whole, after trying different ways, where moderate quantities are raised for home use, and where the supply is chiefly desired for early spring use, as at this season it appears to be more particularly sought, when its crisp and fresh quality is particularly grateful to the palate on the accession of the first warm weather. The mode admits of easy access to it any time in winter.

The treatment differs from the well known mode of placing it in trenches late in autumn, as shown in Fig. 1, only in

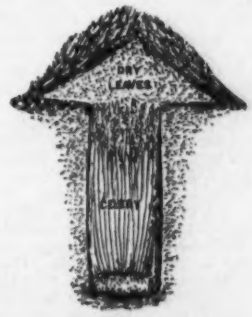


FIG. 1.

the mode of covering. A smooth trench is cut the same width as the spade, and just deep enough to allow the plants to stand erect and reach the surface of the ground. For spring use, the plants are placed in the trench as late in autumn as the weather will allow before freezing up, and as compactly in the trench as may be practicable without bruising. The more common mode is to cover with a rough board roof and then with earth, thick enough to prevent freezing, and an improved mode is to use dry leaves as shown in the cut. A roof of evergreen branches placed over the leaves keeps the leaves in place, and throws off much of the water of rains; but instead of pointing upward as the cut represents, they should be placed tops downward for

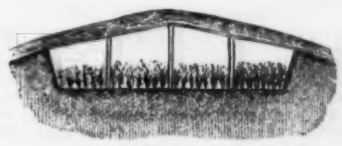


FIG. 2.

carrying off the rain. There is an objection to this mode as represented in the cut. The leaves become more or less wet by near proximity to the earth and by some of the rains from above, and resting on the plants injure them and cause partial decay. This is entirely or easily prevented by first covering the plants well with short evergreen branches laid across and over the plants. On these the leaves are laid in the roof-form as represented, and lastly they are covered with the inverted branches as a two-sided roof. The kinds of evergreen used should be such as naturally lie rather flat, like the common hemlock or the Norway spruce. The chief point to be observed in this method is the use of the evergreen cover directly over the plants, and between them and the leaves. In taking out the blanched celery in winter or spring, a small portion is uncovered at a time, and the clean and fresh appearance of the stems, with their ivory whiteness under the green branches, shows the success of the practice.

For early spring use the plants are not banked up during growth, but are placed green in the trench, where the blanching process is effected; or if for use in winter, all that is necessary is to take them up and place them in the trench earlier in November. As a general rule, the first layer of evergreens across the trench will be a sufficient cover until the ground freezes, after which the leaves are successively added.

Where large quantities are raised they may be stored in frost-proof pits, of greater or less dimensions, covered with board roofs and leaves or straw, as represented in Fig. 2.—*Country Gentleman.*

THE fence question is one of the greatest importance, and it will be solved only in course of time, because the public is educated only very slowly up to the point of satisfactory intelligence. As a rule more money is spent on useless fences than the stock is worth for which the fences are made. By arranging the farm in a suitable manner nearly all the fences may be removed or reduced in cost very greatly, and many millions of dollars saved every year.

POULTRY.

THE value of the poultry consumed in the United States annually is estimated at $300,000,000, or six dollars to each inhabitant. The value of the eggs consumed is set at $240,000,000, or $540,000,000 for poultry and eggs together, or about ten dollars per year to each inhabitant. The number of eggs consumed is claimed to be 9,000,000,000, or 180 eggs to each inhabitant, which would allow one egg to each person every other day. By these figures the average price of eggs throughout the United States is about thirty-two cents per dozen. These estimates were made by Mr. A. M. Halstead of Rye, N. Y., and were given in a lecture delivered before the Indiana State Poultry Association in January last. The figures appear rather high, but may be correct.

The Massachusetts census report for the year 1875 makes the number of eggs produced in the State 41,370,960, which would give to each of her inhabitants twenty-five eggs per year, or one in two weeks. The average price through the year was twenty-six cents per dozen. The number of hens and chickens dressed in Massachusetts in 1875 was 1,012,784, worth $575,374, or 57 cents each. This would give ten dressed hens or chickens per year to each sixteen inhabitants of the State, which is certainly not a very liberal allowance.

According to Mr. Halstead, the value of the poultry in New York State for the year 1875 was $3,000,000. The value of poultry sold, $1,800,000, and the value of the eggs sold the same year was $2,500,000. To supply New York city at the present time requires, says the same authority, 300,000,000 eggs annually, which are worth $8,000,000. This number of eggs will give each inhabitant about twenty-four eggs per month. It will be seen by these figures that the consumption of eggs per capita in New York city and the consumption per capita for the whole country is as 28 to 18. It will be noticed, also, that the States of New York and Massachusetts fall far short of producing enough eggs to supply their capital cities, the greater part of the supply being brought a considerable distance, from other States or from Canada.

The New England farmer is consequently favored with a near market for his poultry and eggs which is not easily oversupplied. As compared with other kinds of live stock, poultry brings the greatest return per pound for the food consumed. Corn turned into beef or pork at the present time is worth about eight cents per pound, dressed weight, while poultry will bring in the same markets fourteen cents per pound, live weight. Money invested in poultry not only pays a larger percentage of profit upon the investment than in any other live stock, but the profit is returned quicker. To grow a steer or cow requires from two to three years; a colt from four to five years; a hog from eight to twelve months; while poultry is ready for the market in from three to four months; and at five months pullets are in condition to pay a daily profit by their eggs.

Now most of these are not new facts, but are known quite generally. A great many people, after figuring out the profits from poultry farming, have started out to make a fortune at the business, but in the large majority of instances the fortune has not been made. Poultry keeping for a profit requires constant care and attention on the part of the keeper, just as the keeping of a dairy of cows, a flock of sheep, or a herd of swine requires care and attention. Comfortable, roomy quarters, a variety of food, and a reasonable degree of cleanliness are among the indispensables.

If one lives at a distance from neighbors, and has his own garden at a distance from his dwelling, it may do to let fowls run at large a considerable portion of the time. It will cost less for food, but of course there will be the necessary annoyance from the filth scattered about door yards. Fowls running at large are more in danger from hawks, foxes, and other animals of prey, especially when accompanied by chickens, than if kept in fenced inclosures. Some have been successful in keeping a few fowls in movable coops which can be carried to the fields were insects are plenty, thus saving a large share of the expense of food and clearing the premises of insects at the same time. Poultry will almost always pay if taken care of as it should be. —*N. E. Farmer.*

MANUFACTURE OF FERTILIZERS FROM SEWAGE.

MENARD and Hennebutte, citizens of France, are the inventors of the following process relating to a method of manufacturing fertilizers from sewage and other waste liquids, which consists in agitating or mixing the same with chloride or sulphate of zinc and with a salt of alumina, then filtering the precipitate and drying the same in the form of cakes to be used for fertilizing purposes.

The precipitation of the heavy matter of sewage and other waste liquids is very easy; but the difficulty lies in obtaining a precipitate of sufficiently slight plasticity to allow rapid and easy filtration, as a thick and plastic precipitate would obstruct and render the operation very laborious. A series of trials has shown that the most satisfactory result is obtained by, first, deodorizing the mass; second, attacking the fatty materials and that series of products to which the sewages owe their viscosity; and, third, combining the heavy matter held in suspension. The treatment of the fatty materials, however, can be dispensed with, if the viscosity is destroyed, by very vigorously attacking those products which hold the nitrogenous matter in suspension.

It is also best in carrying out this process, to use cheap reagents, and a small quantity of which possess considerable energy. The method which has appeared best, because it furnishes a satisfactory manure and allows the filtrations to be carried out easily and quickly, is the following:

First, Deodorizing the mass and attacking the fatty and viscous matters by chloride of zinc, readily obtained by dissolving waste scraps of this metal in muriatic acid; or, in place of chlorides of zinc, by the sulphate of zinc. The chloride of zinc is here specifically mentioned; but of course any cheap metallic chloride that accomplishes a like result in an analogous manner will be the chemical equivalent of chloride of zinc.

Second, More thoroughly attacking and combining the heavy matter by means of a salt of alumina, preferably impure sulphate, in a quantity of about five-thousandths. The salt of alumina is only added after the whole mass has been completely deodorized, being used in solution.

By the use of the above named reagents a precipitate is secured that is susceptible of a rapid and easy filtration, and the residue being dried, a rich nitrogenous manure is thereby obtained from sewage and other waste liquids.

As regards the first step in the treatment of the sewage by the reagents sulphate of zinc or chloride of zinc, the same is to accomplish three results. First, it deodorizes the mass; second, it attacks the fatty and viscous matters; third, it combines in a certain measure with the nitrogenous matter, of which it modifies the molecular condition. Thus, after addition of this reagent, the heavy nitrogenous matter takes the characteristic aspect of small sponges immersed in the liquid. The sulphate of zinc should preferably be employed in solution of 18° Baumé, such as it is when obtained directly by the attack of zinc by a sulphuric solution of the strength of one-tenth of sulphuric acid. This solution gauges about fourteen per cent. of sulphate of zinc. To a cubic meter of sewage is added on an average, and thoroughly mixed, fifteen kilogrammes of this solution, which makes somewhat more than two kilogrammes of dry sulphate of zinc. The preparation and use of the chloride of zinc are analogous to the process just set forth in regard to sulphate of zinc. The sulphate of alumina is used to complete the action of the reagents sulphate of zinc or chloride of zinc, its action being more thorough than that of the sulphate of zinc or the chloride of zinc. It thus completes the attack of the fats and combines in a certain degree with the heavy nitrogenous matter. If used alone, the sulphate of alumina would deodorize the mass, thereby setting free sulphydric acid, which gives rise to inconvenience. Besides, with the amount required when used alone, it would disintegrate the heavy nitrogenous matter to such a degree as to render filtration very difficult. With three kilos of sulphate of alumina, at the most, to a cubic meter of sewage, the attack commenced by the sulphate of zinc is completed.

The process in detail is as follows: The sewage having added to it sulphate of zinc or chloride of zinc, the mass is agitated to secure mixing, whereupon the sulphate of alumina dissolved in a little water is added about ten minutes afterward. The agitation is then renewed. Whereupon the mass is allowed to remain at rest for about fifteen minutes at the least. The solid matter of the sewage is precipitated at about the expiration of the time mentioned.

To treat the entire mass of sewage of about twenty-five kilos heavy nitrogenous matter to a cubic meter, it suffices to take, first, about fifteen kilos sulphate of zinc or chloride of zinc—that is, about two kilos of dry sulphate or chloride—and, second, about three kilos sulphate of alumina—that is, about three kilos dry sulphate—being in all about five kilos of dry reagent. The cakes thus obtained inclose only sixteen to seventeen per cent. inert matter, and their nitrogenous contents is never less than four per cent., and often may reach five and a half per cent. with rich sewage. These cakes are obtained either from the settlement of the precipitate on the bottom of the filter, or, if desired in smaller form, this precipitate may be cut up into small cakes with a trowel or other suitable instrument.

In the cakes obtained the nitrogen is completely fixed and there is a rich supply of nitrogen, and also the filtration or the separation of the heavy matter and liquids is very easy, and the cakes form in the filters without expenditure of mechanical force, and very little care or labor is required.

ON SOME THEORETICAL CONSIDERATIONS CONNECTED WITH THE HARDENING AND TEMPERING OF STEEL.

By Professor CHANDLER ROBERTS, F.R.S.

THE Cutlers' Company of London have, during the past few years, instituted a series of lectures in connection with the general scheme for technical education. The last of the series for the present session was delivered on Thursday, April 12, by Prof. Chandler Roberts, F.R.S., "On some Theoretical Considerations connected with the Hardening and Tempering of Steel."

He traced the history of the subject, and, quoting Guyton Morveau, said that Stahl, the great supporter of the phlogistic theory, considered that iron, "cemented" with carbon in closed vessels, gained phlogiston, and became in consequence steel, and this was the opinion of his disciples, who considered steel to be merely iron possessing the characteristics of a metal in a higher degree than iron, a view which will be found in the works of Henckel, Cramer, Gellert Rinman, and Maquer. Bergman (1781), to whom we owe the discovery of the fact that the presence or absence of graphite makes all the difference in the properties of wrought-iron, steel, and cast-iron, retained the phlogistic theory generally, although he considered that steel contains less phlogiston than wrought-iron. Professor Roberts pointed out that we are still repeating Bergman's question. "How does the graphite act" in producing the singular difference between hard and soft steel? The early experimenters who followed Bergman knew the importance of establishing the action of carbon in converting iron into steel, and Clouet, in 1796, followed by others in this country, converted soft iron into steel by heating it with the diamond. In these early experiments furnace gases had not been excluded, and it was urged that they might have converted the iron into steel without the intervention of the diamond. A past master of the Company of Cutlers, Mr. W. Haseltine Pepys, repeated in 1815 Clouet's experiment, under conditions which left no doubt as to the action of the diamond, for he employed electricity as a source of heat, and thus avoided the action of furnace gases altogether.

It was then shown that in soft, tempered, and hardened steel respectively the carbon has a "distinct mode of existence," and the evidence as to whether carbon in steel is *combined* in the chemical sense, or is merely *dissolved*, was considered at length. The chemical evidence given by Berzelius, Karsten, Gurlt, Forquinon, and recently by Sir F. Abel, the distinguished chemist of the War Department, was then reviewed. With regard to the "solution" theory held by Vandermonde, Berthollet, and Monge in 1786, there is the recent and important calorimetic work of Troost and Hautefeuille, who showed that in white cast-iron, and probably in steel, the carbon is merely dissolved, a view which the lecturer adopted, as he did not consider it to be in any way in opposition to the fact established by Abel, that the carbon left by the slow action of a chromic acid solution is in the form of a definite carbide.

The various physical, as distinguished from the chemical, theories which had been set forth from the time of Reaumur, 1723, to that of Akerman, 1789, to account for the "intimacy of the relation" of carbon to iron in hardened as compared with soft steel, were then described. In recent years much importance had been attached to the physical evidence as to the peculiar constitution of steel, and it had been shown that there is a remarkable relation between the amount of carbon contained in different varieties of steel and their electrical resistance. The latest work, however, in this direction has been done by Prof. Hughes, and his very interesting experiments on the effect of torsion on wires of wrought-iron, soft and hard steel, through which a current is passed, was then described. The effect of hardening in oil on the tensile strength of steel of different degrees of carburization was then shown by the aid of curves, and it was incidentally pointed out that in the case of the variety of steel used for the manufacture of coinage dies a variation of $\frac{1}{10}$ per cent. of carbon makes a great difference in the quality of the metal.—*Chem. News.*

CURVED DIFFRACTION GRATINGS.

IN the *Phil. Mag.* for June, Mr. R. T. Glazebrook enters into a mathematical investigation to show that the concave gratings of Prof. Rowland are subject to aberration effects. He shows that concave gratings may have too large a surface, and that better effects can be obtained by covering over a certain portion of the ruled surface. He finds that in one grating "if its size be reduced to $\frac{3}{4}$ of what it actually is, the extreme lateral aberration will be reduced to about $\frac{1}{4}$ of its actual value, thus becoming about $\frac{1}{12}$ of a centimeter, and the extreme difference of phase in the light of a given wave-length λ reaching any point of the diffracted spectrum will never exceed $\lambda/4$, the dispersion will remain unaltered, the definition and the brightness of the spectrum will both be increased." With lenses of focal length which are indicated, Glazebrook shows that a plane grating ruled on glass, would in certain cases give more light for good definition than a concave grating.

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